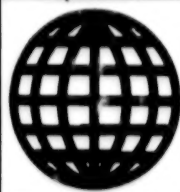


JPRS-UST-95-017

21 April 1995



**FOREIGN
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JPRS Report

Science & Technology

Central Eurasia

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Science & Technology

Central Eurasia

JPRS-UST-95-017

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21 April 1995

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Personnel Reforms Successful in RAS Siberian Division

957A0285A Moscow POISK in Russian
No 4, 21-27 Jan 95 p 2

[Article by Mikhail Buben under the rubric "Panorama":
"Their Example Is Edifying to Others"]

[FBIS Translated Text] "The experience gained in the RAS [Russian Academy of Sciences] Siberian Department could be useful to other regional and special departments of the Academy," stated members of the RAS presidium, the scheduled meeting of which was devoted to discussion of SO [Siberian Department] performance.

Many of the department institutes have adjusted better than "Europeans" to new working conditions. And this, in spite of the fact that in the last 5 years their total basic funding from the federal budget was reduced to one-fifth and, for example, last year the department received 15 billion rubles' less than was due to it. In the same 5 years, one-fifth of the scientific associates left RAS SO institutions. As it is everywhere, in general the situation in the department is not simple but, according to Academician V. Koptuyug, department chairman, there were no drastic changes for the worse. Moreover, it was possible to compensate for the shortage of centralized funding and virtually total absence of funds formerly received under economic contracts with enterprises thanks to collaboration with Russian and foreign foundations and foreign partners.

A considerable part of the department's scientific associates work on a contractual basis, and the contract system has demonstrated its value. It was possible to prevent the attack of commercial entities on research centers of Siberia, thereby fully preserving the material and technical base. New facilities are also being developed, both within the limits of international collaboration on a non-government basis and thanks to the activities of Siberian research centers in the domestic market. Incidentally, on the whole Siberian science and higher education is well supplied with personnel. In recent years, 4000 people left department institutes but 3000 new, mainly young, associates have come in, although the housing problem is very acute. The influx of young forces became possible thanks to a well-organized system of contact between the department's scientific centers and Siberian higher educational institutions. Incidentally, Siberian research centers have become the prototype for creating centers in Japan and West Europe, because they are best prepared to work in the 21st century.

Russian Academy of Sciences Property Issues Await Resolution

957A0285B Moscow POISK in Russian
No 4, 21-27 Jan 95 p 1

[Article by Oleg Lezin under the rubric "Timely Issue":
"About the Status of Property and Status Proper"]

[FBIS Translated Text] While the question of power was the main issue during the Russian revolutions at the start

of the century, the question of property has become an equally disturbing issue in the period of the latest revolutionary transformations in Russia. Amazing as it seems, its resolution was found to be of vital importance to an organization which, as stressed by its management, is invariant (unchanging) as related to any revolutionary changes in the nation. The uniqueness, special position of the Russian Academy of Sciences [RAS] in our society predetermined appearance of a rather intricate situation concerning its status and the status of its property.

At a recent meeting of the RAS presidium, academy experts tried to clarify it, while Oleg Nefedov, RAS vice-president who headed a relevant work group, proposed several steps called upon to correlate the status of academy property and the status of RAS with the first part of the Civil Code that went into effect on 1 January of this year. The authors of the Civil Code, which regulates property rights also, were unable to define the powerful invariant and its economy, and now RAS has to deal with this itself.

At present, the academy must govern itself by a number of documents which are, to some extent, contradictory. In the first place, this refers to the ukase of B. Yeltsin dated 21 November 1991, according to which the RAS received as its property what the USSR AS had owned according to the ukase of M. Gorbachev. In the second place, there are subsequent decrees of the RF [Russian Federation] Supreme Soviet, in one of which RAS property is regarded as being federal, that is handed over for active management to the academy, while another prohibits privatization of its scientific facilities. The situation was ambiguous, but then it allowed the academy to use the advantageous points in all these documents. For example, with reference to privatization issues it referred to the Supreme Soviet decree, whereas in general it based itself on the President's ukase, including work with the SCP ["Goskomimushchestva"—State Committee for Property].

The approved Civil Code required clearer familiarization with the legislative base. In the opinion of Oleg Nefedov, if RAS intends to retain the status of owner in accordance with the President's ukase, it is necessary to submit a list of academy property for approval by the government or SCP. After it is approved, RAS will be able to transfer property credited to academy institutions for active management by them. "This is the optimum variant," said O. Nefedov. "We are prepared to also concede a number of restrictions, since we did not have the sense that someone wants to acquire the property for mercenary purposes." The second variant, in which RAS receives property for use, ownership, and disposition with the rights of active management, which is spelled out in the decree of the RF Supreme Soviet dated 27 December 1991, does not suit the academy, since in this case transfer of property to active management by institutes would not proceed through RAS, but through SCP. O. Nefedov believes that "if the 400 academy institutes regulate property rights directly with

SCP, it would break up the RAS." The fact that the academy must have deal directly with all property is confirmed by the incidents involving court arrests: what institute could afford to pay the enormous fines and "save the ships"?

In the opinion of academy lawyers, in the immediate future it is necessary to prepare a draft state of legal aspects of RAS property, amendments and clarifications to the academy bylaws, and a draft of a new presidential ukase concerning the Russian Academy of Sciences with due consideration of the basic points in the Civil Code.

Viktor Mozolin, chief scientific associate at the Institute of Government and Law, offered a clarification: "The rights of ownership are 'tied in' by legislation with the status of organizations. RAS does not fall into the category of any form of nonprofit organization, including public ones stipulated in the Civil Code. We shall have to 'individualize' our legal status by means of a law concerning the academy." Viktor Mozolin also reminded us that the problem of academy status is touched upon in draft laws on science that are now "cooking" in the Duma. It is possible that the law on science will have points that contradict the presidential ukase that is being drafted.

The situation with RAS property and status of the academy itself is rather complex. Even experts are not sure that the above steps will unequivocally lead to positive results. Could the RAS drown in its property? Will it not be accountable for any property-related sins committed regarding property by the institutes? The situation is also aggravated by the fact that SCP chairman Vladimir Polivanov, with whom the academy succeeded in establishing contact, was removed from office. In any case some of the internal documents should already be prepared for the general meeting. The discussion will continue there.

Soros Foundation to Continue Work Despite Espionage Accusations

957A0286A Moscow POISK in Russian
No 4, 21-27 Jan 95 p 2

[Letters by Academician Vladimir Skulachev, chairman of Russian Consultation and Observation Council of IRF, and Academician Vladimir Fortov, chairman of Russian Foundation for Basic Research, under the rubric "Readers' Opinion?"; first two paragraphs are POISK introduction]

[FBIS Translated Text] As we know, Gosduma deputies have decided to include on the agenda of a plenary session the question of activities of the Soros Foundation in Russia. In this regard, the International Research Foundation [IRF] established by G. Soros gave a statement to the press in which public scrutiny of IRF activities is welcomed. The statement expresses hope that this will put an end to the numerous rumors and conjectures.

In the meantime, letters were received by our editorial board from scientists and research organizers with their reactions to the excerpts from a report of the Federal Counter-Intelligence Service [FCIS], which were published in NEZAVISIMAYA GAZETA [NG]. We submit here two such letters for POISK readers.

[Letter from Academician Vladimir Skulachev]:

International Research Foundation Continues Its Work in Russia

The phrase in the heading of this article received approval on Tuesday 17 January, when George Soros held a press conference in the Slavyanskaya hotel. The question arose a week earlier, after publication in NEZAVISIMAYA GAZETA of an article under the heading of "FCIS is Concerned With Activities of American Researchers in Russia (From a Report of the Federal Counter-Intelligence Service)." In this article the IRF was mentioned in the following context: "While proclaiming officially that its purpose is to aid in development of Russian science, the centers (it is obvious from the foregoing that this refers to some American research centers) are trying to sign contracts with our scientists for transfer of exclusive rights to use discoveries and inventions, thus actually dooming Russian science and economy to American-controlled foot-dragging. Thus, the International Research Foundation (U.S.) has received 885 documents on scientific developments from private and legal sources, including 76 from Russian research institutions. Private individuals were paid \$500 each and research organizations, \$100,000 each, regardless of the nature of the scientific document. Paperwork on scientific developments were sent to this foundation from different Russian cities, including those that impose special conditions on foreign visitors (Arzamas-10, Ufa-70, Kazan-103, Kazan-34, Perm-7, Izhevsk-8, and others). The Soros foundation offers grants for scientific information to Russian research institutions, i.e., funding of research for 1-2 years at the rate of \$100,000. In mid-1993, patents were pending in the United States for about 3,000 Russian technologies that would yield billions of dollars in profit. In addition to the commercial sector, a clear-cut system of evaluating and selecting Russian technologies was set up in the United States for the needs of its military industrial complex. Analysis of American questionnaires by specialists indicates that in the course of interviews U.S. research centers have the opportunity to obtain information about the subject, his relatives, where they work, who their supervisors are, and other data" (NG [NEZAVISIMAYA GAZETA] 10 Jan 95).

The facts of this matter can be illustrated by the official IRF documents cited below:

1. "IRF relinquishes all rights to intellectual property resulting from its funding of research" (IRF statute on long-term grants, see POISK, No 25, 1993).

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2. "The (IRF) program extends only to civilian research in basic natural sciences. Applied sciences, including clinical studies and conversion, and humanitarian sciences may not be supported by IRF" (Ibid).
3. The emergency aid program implemented in early 1993 consisted of remitting sums of \$500 each to 26,000 scientists who had published at least 3 articles in the last 5 years in the leading domestic and foreign journals with an impact factor above a certain critical level. Since definitions of impact factor were taken from the manuals of the International Institute for Scientific Information in Philadelphia, our list included journals that appear in these manuals, which are published annually in the United States. In addition to summaries of 3 articles, which are also contained in the data bank of the Philadelphia Institute, applications for aid included identification data needed to collect funds in a bank. No information about supervisors, relatives, place of employment, etc., was requested.
4. IRF has never allocated any \$100,000-grants to 76 organizations. Organizations in which winners of a competition for long-term grants are employed automatically receive 20 percent of the grant to support their infrastructure. No inquiries or other materials are required of the organizations.

As for scientists from "secret cities" (I first heard about the existence of most of them in the NG publication), most of them could not even apply for the IRF competition for two reasons: by virtue of the applied nature of their work and absence of publications in the open press.

In general, all activities of IRF are aimed at gaining information from abroad, rather than sending it abroad. Suffice it to mention that last year alone IRF purchased and delivered to our libraries more than 300 tons of prominent international journals dealing with natural sciences.

B. Saltykov, Russian Federation Minister of Science and Technological Policy, announced that the unsigned document published in NG on 10 January 1995 had not been received by the ministry. Nor did M. Kirpichnikov, head of the RF [Russian Federation] Government Department of Science and Education, know anything about it before its publication in NG. A. Mikhaylov, chief of the FCIS Center for Public Relations, stated that he had not seen such a report "within the walls of FCIS" (IZVESTIYA, 18 Jan 95). A facsimile of a letter of appreciation from V. Chernomyrdin to G. Soros dated 14 March 1994 was published on the first page of the same issue of IZVESTIYA. G. Soros was received by B. Yeltsin in January 1993 who had expressed the wish to thank the American patron personally for establishing the IRF. Very recently, on 8 November 1994, the RAS [Russian Academy of Sciences] presidium discussed the activities of IRF and adopted the following resolution:

- "1. To express deep gratitude to the founder of IRF, G. Soros, for his noble initiative to support Russian science and to the staff of the foundation for all the work done to give real assistance to scientists at a difficult time for the nation.
- "2. To recognize the great importance of IRF as the only organization thus far in Russia that has created an infrastructure instrumental in distributing effectively foreign charitable aid to science.
- "3. In its desire for IRF to continue its programs of assistance to Russian science, it should apply every effort to obtain additional funds for the Foundation from foreign nations and international organizations."

IRF activities have always been supported by the RF Ministry of Science and Technological Policy, which accredited the foundation since its inception. B. Saltykov, minister of science, is a member of the Russian Consultation and Observation Council of IRF.

On 14 January, upon reading the NG article, G. Soros made a statement to the mass media to the effect that he will stop funding by IRF and his other programs in Russia if its leadership has changed its opinion about these initiatives. On 16-17 January, he met with RF Vice-President S. Shakhrai and Minister B. Saltykov, who confirmed the unchanged official position of the RF government. The same was declared by N. Vorontsov, chairman of the Duma's Science Subcommittee.

In general, however, Soros did not go to Russia because of the unpleasantness provoked by the article in NG; he came for charitable purposes. During the meeting with S. Shakhrai he offered emergency aid amounting to \$5 million to the Russian government for victims of the Chechnya tragedy. It is planned to deploy a 200-bed hospital near Grozny. However, IRF was not involved in this, although G. Soros instructed P. Arsenyev, director of the IRF Moscow office, to take care of this matter at first, in view of its urgency.

P. S. After I sent my manuscript to the POISK editorial office, an event occurred that raised doubt as to whether a question mark should follow the heading of this article. On 20 January, Duma decided to examine the activities of Soros foundations in Russia. I am even glad that the Duma's science subcommittee analyzed the performance of IRF, which could put an end to the NG article affair. However, on the other hand, a negative verdict by the Duma will terminate activities in our country of both IRF and other charitable foundations. As for the funds remaining in the IRF budget, in this unfavorable case they will be transferred to the foundation's department in other republics of the former Soviet Union.

Late last year we discussed with the Moscow scientific community the question of whether it would be worthwhile for us to lobby in the American congress for the plan to allocate several million dollars from the U.S. budget to support IRF. We subsequently learned from

American scientific circles that U.S. scientists have taken on this task. But it is unlikely that they would help us in our own parliament. This is why I should like to address a request to Russian scientists to express their feelings about activities of IRF and other foundations. This could be done in a very concise way, in the form of letters from scientific associates to the RF State Duma science subcommittee (103012, Moscow, Okhotnyy ryad St., No 1). *The International Research Foundation will continue its work in Russia if you support it.*

[Letter from Academician Vladimir Fortov]:

What Is the Real Danger?

I believe that the statement published in NEZAVISIMAYA GAZETA on 10 January 1995, to the effect that the activities of the Soros Foundation are detrimental to the national interests of Russia shows lack of knowledge in the matter. George Soros was the first to render real assistance to our science, education and culture in an extremely difficult transitional period, and we should be grateful to him for it.

Soros' charitable foundation does not in principle deal with applied work and supports only basic research which is always open by its very nature. From the very beginning, the work of the Soros Foundation in Russia proceeded in close contact with the Ministry of Science and Technological Policy and top-level officials in our country. B. Yeltsin and V. Chernomyrdin have met with G. Soros in person, approved his work and provided an entire system of preferential terms to assure utmost effectiveness in using allocated funds to support Russian scientists.

Recently, the Russian government and Soros Foundation agreed to allocate \$12.5 million each for joint additional support of scientific projects submitted to the International Research Foundation. For this purpose, about 500 projects were transmitted from the Soros Foundation for additional expert evaluation to the Russian Basic Research Foundation. A close examination of these projects confirmed that there are no grounds to talk of any leaks of information, any comprehensive article in a scientific journal could also be considered a leak.

The current policy of dramatic reduction of allocations for science and education, which inflicts fatal blow to scientific schools, institutes and all scientists in our country, presents a real danger to Russian national interests. Our scientists have been placed in a position bordering on physical survival, and the brain drain has acquired the features of mass escape of young people from science. If the 1995 budgeted expenses for science are not increased, it will be the last step toward collapse of science in Russia, toward estrangement of our society. We are taking the risk of forever losing serious science in Russia.

Scientist Defends Western Aid Programs, Refutes Spy Charges

957A0286B Moscow ROSSIYSKIYE VESTI in Russian
3 Feb 95 p 2

[Article by Professor Igor Kon, under the rubric "Opinion": "One Should Look for Spies, but It Should Be Done in the Right Places"]

[FBIS Translated Text] The report published on 11 January in NEZAVISIMAYA GAZETA seemed painfully familiar to me. We have read many times items signed by Kryuchkov, Andropov, Semichastnyy, Shlepin, Beriya and their associates to the effect that we are surrounded on all sides by spies. Is this true? Espionage and the struggle for influence have always existed everywhere. It would be strange if now, when everything in our country is being sold at wholesale and retail, and cheaply at that, there were no western intelligence service and simply marauders.

The Soviet Union was a giant conglomerate, although people born there were not aware of this. As soon as prison doors were ajar, the most enterprising "prisoners" ran off, taking everything they could with them, including the secrets of others. The rest, who were unable or did not want to do this, those who loved their country, remained to rebuild. But many did not realize that it is not necessary to break down prison buildings or to chop down the surrounding forest in order to break down the prison system, we will still live there, and no one will make us the gift of a new zone. It also became difficult to tell friends and enemies apart.

Unfortunately, the authors of the FCIS [Federal Counter-Intelligence Service] report lump together American intelligence and virtually all scientific and humanitarian organizations that are studying our problems. I have often made public statements expressing my profound disgust with Americanization of Russian culture. But why a universal smear? Scholarships and grants made by the Soros Foundation and other western organizations helped hundreds of Russian scientists to survive physically and continue their research; otherwise, they would have had to emigrate or sell books on the streets, as is the case with one of my former students, a doctor of sciences and author of five monographs, who cannot feed his three children on the salary of a leading scientific associate.

We are frightened by the fact that American researchers are working in our libraries and archives. What is wrong with that? We too now have the opportunity to work in foreign book depositories if some western foundation pays our expenses (Russian scientific institutions have no money, not only for professional business trips, but also even postage stamps). I personally am very grateful to the Russian Center at Harvard University and the Kennan Institute for such assistance, and no one ever recruited me anywhere. The Americans not only pay their own expenses, but even pay exorbitant fees to our

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archives, without which they would alas close down entirely. The American foundations operating in our country are usually nonprofit. And what does the U. S. government gain from such exchanges? In the first place, it is beneficial to any country for its specialists, whoever employs them, to be experts in their field. Only in the USSR was it possible to become a leading specialist in, for example, Australia, without ever having been there. In the second place, international collaboration not only improves mutual understanding, but also enhances the prestige of the country that funds it. In the long term, this is more profitable than the most successful espionage.

No doubt, some American organizations, not only government ones, are engaged in propaganda in our country, including young people. All countries do this. Just remember our Artek, the Lumumba Institute and many others. The only way to counteract alien influence is to have our own analogous organizations perform better. But what does this have to do with FCIS?

The FCIS is movingly concerned with our brain drain. But the only way to stop it is to raise dramatically the salaries for scientists and, what is even more difficult and expensive, to provide conditions for fruitful work. If FCIS is willing to donate part of its own budget to

impoverished science, we welcome it. If not, why the crocodile tears? Or do you expect to hold back the brain drain by reinstating exit visas?

Of course, it is necessary to protect state, scientific, technological and commercial secrets against foreign governments and commercial entities, and this is one of the main FCIS duties. But in the era of modern electronics, the old KGB methods—to hold and detain—are powerless and have the opposite effect. Moreover, the broader the spectrum of classified matters, the less effective is control. We learned this long before perestroika from translations of American books. I believe that this is also known to FCIS.

The report of FCIS, or as I would like to believe the fake text claiming to be such a report, which was published at a time of political crisis and aggravation of the international situation, is not a professional analytical document, instead it is a primitive ideological diversion intended to generate in our country spy hunts and old bans. And at the same time, to offend the western community and support American conservatives fighting to shut down humanitarian, scientific and other aid to Russia, meager as it is.

Physical Modeling of Directed Transport of Laser Radiation Energy

957A0374A St. Petersburg OPTICHESKIY ZHURNAL
in Russian No 11, Nov 94 (manuscript received 2 Jun 94)
pp 37-41

[Article by V. S. Sirazetdinov and A. D. Starikov, doctor of physical and mathematical sciences, All-Russian Science Center State Optical Institute imeni S. I. Vavilov; UDC 621.373.826]

[FBIS Abstract] A method for physical modeling of extended (tens of kilometers or more) optically homogeneous paths in the laboratory is proposed and the results of model experiments for ascertaining the efficiency of energy exchange between remote sources and detectors by use of a phase conjugation-pickup algorithm are given. The possibility of organizing optically homogeneous paths for beams with a diameter of several centimeters propagating over distances of several hundred meters was experimentally checked in a laboratory room specially protected against convective air currents. A laser beam of diffractive quality was transmitted along such a path for a distance up to a kilometer, in the process experiencing up to 24 reflections from high-quality intermediate mirrors. The beam diameter upon entry on the path was 30-50 mm, the radiation wavelengths were 0.53 and 1.06 μm and the radiation power was about 100 MW. Up to 750 m beam disturbances remained at the subdiffraction level. It is shown by extrapolation that by using a path 1000 m long it is possible to simulate optically homogeneous paths up to 100 km in length. These studies on an artificial path made it possible to optimize the process of energy exchange between receiving-transmitting systems with limited apertures and revealed the possibility of concentrating the return ray in the reception zone solely by means of diffraction effects. The described simple illustrative example of an easily organized experiment therefore demonstrates the effectiveness of the described approach in physical modeling of the processes of propagation of optical radiation over considerable distances. Figures 5; references 12: 11 Russian, 1 Western.

Spectrum of Doppler Shifts of Coherent Radiation Scattered by Oscillating Rough Surface

957A0374B St. Petersburg OPTICHESKIY ZHURNAL
in Russian No 11, Nov 94 (manuscript received 2 Jun 94)
pp 48-53

[Article by I. A. Popov, candidate of physical and mathematical sciences, All-Russian Science Center State Optical Institute imeni S. I. Vavilov; UDC 535.36]

[FBIS Abstract] The changes in the spectrum of Doppler shifts of the coherent radiation scattered on the surface of an oscillating rough body caused by the speckle effect are computed and an evaluation of the correlation of harmonics in the spectrum is presented. (The error in

determining the parameters of the mechanical oscillations caused by the presence of the speckle pattern is dependent on the procedure for processing the signal in each specific device and therefore is not examined.) The analysis is made using an approach proposed earlier (I. A. Popov, et al., OPT. COMMUNS, Vol 105, No 3-4, pp 167-170, 1993). It is found that due to the speckle effect the amplitudes of the harmonics in the spectrum are subjected to strong fluctuations. Due to the nonstationarity of the process the spectral components are random correlation values. With the α parameter in (9) the quite small set of harmonics fluctuates as a whole and the amplitudes of the harmonics correlate well with one another. With the β parameter in (8) considerably greater than 1 (for all practical purposes when $\beta > 10$) sets of even and odd harmonics are completely correlated with one another. [The key parameters α and β enter expressions (8)-(9) derived for the correlation function for the field of scattered radiation.] The correlation between the two sets decreases with an increase in the α parameter. When $\alpha > 1$ there is complete decorrelation between even and odd harmonics. The indicated properties make it possible to eliminate the influence of speckle noise on the spectrum of scattered radiation. Figures 2; references 14: 8 Russian, 6 Western.

Change in Optical Characteristics and Destruction of Glasses Under Influence of Powerful Laser Radiation

957A0374C St. Petersburg OPTICHESKIY ZHURNAL
in Russian No 11, Nov 94 (manuscript received 2 Jun 94)
pp 67-73

[Article by O. M. Yefimov, candidate of physical and mathematical sciences, All-Russian Science Center State Optical Institute imeni S. I. Vavilov, UDC 535.21: 621.373.826:666.11.01]

[FBIS Abstract] This is a review of the principal results in the field of physics of interaction between powerful laser radiation and transparent dielectrics. The processes determining the stability of silicate glasses and the reliability of functioning of optical elements made from these materials with long-term exposure to strong laser radiation are discussed. Emphasis is on summarization of the work of the State Optical Institute. Crown and flint glasses were studied; these were specially synthesized from materials of ultrahigh purity with a mass concentration of impurities not greater than 10^{-4} percent. YAG [yttrium-aluminum-garnet] and phosphate glass lasers generating the same longitudinal and transverse modes were used. The laser radiation was transformed into higher harmonics and focused in samples made in the form of polished plane-parallel plates 0.2 to 30 mm thick. Among the subjects discussed are: mechanisms of change in refractive index of silicate glasses, influence of impurity ions on electron processes during laser excitation of silicate glasses, factors influencing the reliability in measuring the threshold parameters of optical breakdown, characteristic optical breakdown of

silicate glasses and effect of accumulation with repeated exposure to laser radiation. The review makes clear the wide diversity of phenomena determining the stability of the parameters of transparent media and the reliability of functioning of optical elements under conditions of long-term exposure to strong laser radiation. Despite the more than 30 years of experience in studying the physical processes which arise there is no complete understanding of many of them, but the results obtained, methods which have been developed and the further development of such fields as the physics of interaction between optical radiation and matter, materials science, laser technology, nonlinear optics and the designing of unique focusing systems and scientific instruments promise successful solution of all these problems. References 30: 26 Russian, 4 Russian.

**Feasibility of Developing Driver for Laser
Thermonuclear Fusion Based on Chemical
Oxygen-Iodine Laser**

957A0373A Moscow KVANTOVAYA ELEKTRONIKA
in Russian Vol 22 No 1, Jan 95 (manuscript received
25 Mar 94) pp 12-20

[Article by P. G. Kryukov, Physics Institute imeni P. N.
Lebedev, Russian Academy of Sciences]

[FBIS Abstract] The feasibility of developing a driver for
laser thermonuclear fusion based on use of the second
harmonic of an oxygen-iodine laser as a source for

pumping solid-state lasers (such as crystals activated by
chromium ions) is explained. In contrast to existing
schemes it is proposed that in each driver channel use be
made of an individual master oscillator. The scheme is
characterized by a simple technology, ensures a high
uniformity of target irradiation and makes it possible to
form an optimum profile of the heating pulse using a set of
wavelengths 0.8, 0.4 and 0.27 μm . The structure of the
driver channel and its operation are illustrated in a series
of diagrams, serving as a basis for its detailed discussion.
The principal advantages of the proposed system are as
follows. In comparison with schemes based on neodymium
glass a lower cost of the laser is anticipated. It is not
necessary to develop complex technologies and the energy
is generated from simple accessible substances (to which a
separate section is devoted). The proposed scheme is
precise since it makes it possible to control pulse shape and
carry out experiments with an optimum form of the
shaped pulse and with a high degree of uniformity of the
irradiated target (a diagram shows the pattern of target
irradiation). The wavelength in this scheme (0.8 μm) is
substantially shorter than when using neodymium gas
(1.06 μm) and photodissociation iodine lasers (1.315 μm).
There is a possibility for combining long- (fundamental
frequency) and shortwave (second and third harmonics)
radiation. The total efficiency of the proposed system is
about 10 percent and operation with a repetition rate of
about 20 Hz is entirely realistic. Figures 13; table 1;
references 35: 13 Russian, 22 Western.

Visualization of Solid Phase Reaction of Anisylmercury- and Triphenylphosphinegold Derivatives of Phthaleines with Bromides

957A0350A Moscow IZVESTIYA AKADEMII NAUK SERIYA KHIMICHESKAYA in Russian No 12, Dec 93 (manuscript received 20 Nov 92 after revision 28 Aug 93) pp 2115-2117

[Article by V. A. Nikanorov, L. N. Ssytkulova, Ye. S. Shubina, L. M. Epshteyn, A. V. Usatov, and Ye. I. Smyslova, Element Organic Compounds Institute imeni A. N. Nesmeyanov, Moscow; UDC543.422:547.633.6]

[FBIS Abstract] Visualization of the reaction of a new class of metal-containing indicators (ligandochromes) with solid salts of hydrobromic acid, called ligandochromism, is reported for the first time. Infra-red and electron spectroscopy were used to study the visualized solid phase reaction of bis-O-metalized phenol- and xylenolphthaleins (where $M = \text{HgC}_6\text{H}_4\text{OMe}$ and AuPPh_3) with salts of hydrobromic acid. The appearance of a bright coloration (purple, violet, or blue) after brief grinding of colorless or slightly colored solid samples with the salts is the result of their ionization and formation of ion pairs or di-anions, depending on the nature of the counter-ion. The reaction affects only a small part of the surface molecules of the metal complexes. Figure 1; table 1; references 5: 4 Russian, 1 Western.

Structure of Reaction Products of 2-Cyanoaziridine with Carbonyl Compounds

957A0350B Moscow IZVESTIYA AKADEMII NAUK SERIYA KHIMICHESKAYA in Russian No 12, Dec 93 (manuscript received 17 Nov 93) pp 2136-2139

[Article by K. F. Keler, Kh. Tsaddakh, G. K. Kadorkina, V. N. Voznesenskiy, I. I. Chervin, and R. G. Kostyanovskiy, Society for Liquidation of Military Weapons, Toxicants, and Toxic Supplies, Munster, Germany; Chemical Physics Institute imeni N. N. Semenov, Moscow; UDC541.63:543.422.25:547.717]

[FBIS Abstract] The products resulting from the reaction of 2-cyanoaziridine with carbonyl compounds, especially acetone which yields azimexone, are of great interest and are being studied intensively as immune stimulants, antitumor, and anti-radiation agents. Azimexone is an antidote for both nitrogen and sulfur mustard gases. However, non-contradictory data on the structure of these compounds is still lacking. In the present work NMR-spectra was used to confirm the structure of the reaction product between 2-cyanoaziridine and acetone as azimexone. This compound is formed as a result of α -1-aziridinoalkylation of an intermediate product containing a readily displaceable iminoyloxy group. Similar reactions were also observed for 1-chloromethylaziridine and 1-aziridine-omethylammonium salt, but for not 1-methoxymethylaziridine and 1-aziridinocarbonols. Figure 1; table 1; references 18: 11 Russian, 7 Western.

Synthesis and Study of New Mixed Oxides of Series $A^{\text{I}}\text{Nb}^{\text{V}}\text{UO}_6$

957A0349A St. Petersburg ZHURNAL OBSHCHEY KHIMII in Russian Vol 64, No 1, Jan 94 (manuscript received 30 Sep 93) pp 3-5

[Article by N. G. Chernorukov, Ye. V. Suleymanov, N. P. Yegorov, and I. M. Romanenko, Nizhegorod State University imeni N. I. Lobachevskiy; UDC546.311-31, 791.6-31]

[FBIS Abstract] Certain triple mineral-like mixed oxides containing uranium, niobium, and alkali metals are interesting from both the theoretical and practical points of view as stable ceramic matrices for immobilization of radionuclides. Data have been presented on the synthesis of K-, Rb-, and CsNbUO₆ by high temperature solid phase reactions. The crystal structure of these compounds was built on infinite layers of $[\text{NbUO}_6]^{n-2\infty}$. The space between the layers contained alkali metal cations which in many cases are capable of being replaced by other cations. Attempts to prepare similar compounds containing other alkali metals such as lithium and sodium were unsuccessful. In the present work ion exchange was used to synthesize the new sodium and lithium analogs of the title oxides and their crystal hydrates. These compounds were further investigated using X-ray diffraction, thermography, and IR-spectroscopy. Tables 3; references 4: 2 Russian, 2 Western.

Features of Extracting Triethylamine from Aqueous Solutions

957A0349B St. Petersburg ZHURNAL OBSHCHEY KHIMII in Russian Vol 64, No 1, Jan 94 (manuscript received 3 Jun 93) pp 142-148

[Article by R. G. Makitra, Ya. M. Vasyutyn, Ya. N. Pirit, G. G. Midyana, and I. Ya. Senkiv, Physical Chemistry Institute imeni L. V. Pisarzhevskiy, Lvov; UDC541.123.2+547.233]

[FBIS Abstract] Organic amines, especially aromatic amines, are highly toxic substances with a maximum allowable concentration of 10 mg per m³ in natural media, and therefore data concerning their equilibria in organic solvent-water systems is pertinent as a basis for extraction refining of industrial effluents containing these substances. Much research has been devoted to the system water-amine-organic solvent and numerical data on the distribution constant K_r is contained in handbooks. However, careful examination of the handbook data reveals that 1) there is a divergence among various authors; 2) there is an insignificant amount of data on solvents capable of specific reactions with amines as well as for solvents now in use; 3) there is a lack of quantitative or even semi-quantitative correlated data on K_r regarding the properties of extractants which prevents predicting extraction efficiency of uninvestigated solvents. In the present work K_r values were determined for

triethylamine mixtures with water and 21 organic solvents. The values may be correlated with the physical chemical properties of the solvents by using multi-parameter formulas in which the capability of the extractants for non-specific and nucleophilic solvation has special significance, although the coefficients in the formulas are different for various groups of solvents. Figures 2; tables 3; references 15: 10 Russian, 5 Western.

Analysis of Evolution of Dispersed Phase of Fine Suspension During Coagulation and Fragmentation

957A0279A Moscow *KOLLOIDNYY ZHURNAL* in Russian Vol 56, No 1, Jan-Feb 94 (manuscript received 22 Mar 93) pp 97-104

[Article by Ye. V. Semenov, Moscow State Academy of Food Production, Moscow; UDC 541.18.04+541.18.05]

[FBIS Abstract] A study was made of the overall particle size composition in very fine particles suspended in liquid or gas dispersion media, under the assumption that evolution of powder dispersion is affected by coagulation and spontaneous fragmentation. It was further assumed that only paired collisions took place and that random forces disrupt the system in such a manner that the behavior of the particles between the acts of coagulation and fragmentation are statistically independent. Under these conditions evolution of the particle size composition of the powder may be described within the framework of the Smolekowski kinetic equation. It is postulated that the mixture exists under quasi-equilibrium conditions and that the concentration of the solid phase is not great. Figure 1; references 19 (Russian).

Cesium 137 and Strontium 90 in the Gulf of Gdansk and Southern Part of the Baltic Sea in 1982-1985

957A0351A Moscow *VESTNIK MOSKOVSKOGO UNIVERSITETA - KHIMIYA* in Russian Vol 35 No 1, Jan-Feb 94 (manuscript received 1 Jun 93) pp 43-47

[Article by R. Stoyachik, Ya. Tomchak, Yu.A. Sapozhnikov, Radiochemistry Department, Moscow University; UDC 539.16:551.16]

[FBIS Abstract] The distribution of cesium 137 and strontium 90 in the Gulf of Gdansk and southern part of the Baltic Sea was studied systematically from 1982 through 1985. Unfiltered water samples (20 to 50 l in volume) were collected by using a plastic bathometer manufactured by the firm Kahlsico. The cesium 137 present in the sea water samples was concentrated by using ammonium phosphomolybdate to which a carrier (20 mg of stable cesium) had been added. The strontium 90 present in the samples was concentrated by precipitating it in oxalate form in an ammonia medium to which 1 g of stable strontium had been added as a carrier. Samples of the atmospheric precipitation falling over the study area and samples of the study area's bottom sediment were also collected and

analyzed. Between 1982 and 1985, the concentration of cesium 137 in the Gulf of Gdansk decreased from 15.8 ± 2.1 Bq/m³ to 11.2 ± 2.1 Bq/m³, whereas over the same period the concentration of cesium 137 in the southern part of the Baltic Sea (excluding the Gulf of Gdansk) decreased from 19.4 ± 2.9 to 13.4 ± 1.3 . Similarly, from 1982 to 1985, the concentration of strontium 90 in the Gulf of Gdansk decreased from 22.6 ± 1.5 to 15.4 ± 1.5 Bq/m³, whereas over the same period, the concentration of strontium 90 in the southern part of the Baltic Sea decreased from 22.3 ± 2.3 to 17.5 ± 0.5 Bq/m³. During the course of the study, the concentration of cesium 137 observed in the surface layer of sea water in the vicinity of Gulf of Gdansk changed less than did the concentration in the southern part of the Baltic Sea. The shore area of the Gulf of Gdansk had a noticeably lower concentration of cesium 137 than did the remainder of the gulf area on account of the high degree of dilution of the sea water with the waters of the Vistula River, where cesium 137 concentrations were low. The concentrations of cesium 137 in the bottommost layer of water in the Gulf of Gdansk and especially in the southern part of the Baltic Sea changed more because of the influx of cesium 137-contaminated waters from the North Sea through the straits around Denmark. As a result, up to 95 percent of the cesium 137 in the Baltic sea was concentrated in its bottommost layers of water. At the same time, the contribution of the nuclear power plants located on the Baltic's shores to the sea's overall levels of cesium 137 and strontium 90 was relatively small. This conclusion was confirmed by the distinct relationship between the concentration of cesium 137 and the salinity of the waters of the Gulf of Gdansk and the southern part of the Baltic Sea (correlations of 0.83 and 0.76, respectively). Tables 3; references 12: 8 Russian, 4 Western.

Corrosion-Resistant Epoxide Materials

957A0359A Moscow *KHIMICHESKAYA PROMYSHLENNOST* in Russian No 2, Feb 94 pp 89-91

[Article by V.M. Kuznetsova, L.F. Podgornaya, R.A. Yakovleva, T.N. Obizhenko, and O.A. Danilyuk, Kharkov Polytechnic Institute; UDC 678.643'42'5: 620.193.4]

[FBIS Abstract] Epoxide oligomers with a low solidification temperature and composites based on them are used to seal instruments and various subassemblies of electrical and electronic equipment. Because of the importance of keeping the components of electrical and electronic equipment free of corrosion, a study examined the corrosion resistance of a number of epoxide polymers produced by using various amine hardeners in the presence of active modifiers to harden ED-20 epoxide oligomer (ester number, 21.8 percent). The following epoxide polymers were studied: ELA-1, ELA-2, ELA-3, DLD, ELP, EZK-6, ADER, and ADEE. The corrosion resistance of each of the aforesaid polymeric materials was estimated by determining the concentration of chlorine ions in the hardened material by means of an

FEK-n-57 photoelectrocalorimeter, the pH of a water extract of the polymeric material, and the relative coefficient of mirror reflection of copper plates that had been exposed to the study materials for 30 days under conditions of open air or else 60 percent relative humidity at 70°C. In the test conducted involving the copper plates that were conducted in air, all of the study materials with the exception of EZK-6 were classified as inactive or only slightly active. The polymers based on ELA-3 and ELP performed best in the said test. After 30 days, the relative coefficient of mirror reflection of the copper plates coated with the epoxide polymers ELA-3 and ELP changed less than 20 percent. The pH of aqueous extracts of each of the study epoxide polymers remained unchanged (pH 6-7). In the tests conducted under 60 percent relative humidity, the polymer based on the composite ELA-1 demonstrated the lowest level of corrosive activity. The two products of radiation-chemical hardening of oligomers, i.e., ADER and ADEE, remained free of corrosive activity in both cases. With the exception of the polymer based on the composite EZK-6, all of the study materials manifested either no or only slight corrosive activity (i.e., their coefficient of mirror reflection changed by less than 60 percent). The reactive modifiers oligoestercyclocarbonate and oligoesterepoxy that are used in the composites ELA-1, ELA-2, ELA-3, ELD, and DLP have been demonstrated to participate in the formation of the polymer's cross-link structure and result in the formation of more stable and water-soluble polymers. The deterioration of the copper plates observed in the tests of EZK-6 was attributed to the presence of polyethylenepolyamine in EZK-6, which was hypothesized to result in the development of significant internal stresses and absorption of water. Estimation of the study polymers' chlorine ion levels established that all of the polymers may be classified as not aggressively corrosive: Except for the composite based on EZK-6, all of the study materials had chlorine ion levels not exceeding 0.02 percent. All of the epoxide polymers tested were thus confirmed to remain corrosion resistant and maintain their dielectric and adhesive strength properties when held at 125°C and were thus deemed suitable for use in electrical and electronic equipment as sealants and adhesives. Figure 1, table 1.

Effect of Laser Radiation on Kinetics of Electroprecipitation of Selenium Coatings Produced From Fluoride Electrolytes and Their Properties

957A0381A Moscow ELEKTROKIMIYA in Russian
Vol 30 No 2, Feb 94 (manuscript received 7 Feb 92)
pp 206-210

[Article by V.M. Bigelis, T.I. Parmanov, and A. Rakhmanov, Nuclear Physics Institute, Republic of Uzbekistan Academy of Sciences, Ulugbek; UDC 541.135.6]

[FBIS Abstract] In an effort to produce high-ohm galvanic coatings, a study examined the possibility of producing electroplated selenium coatings by electrolysis

of selenonic fluoride-containing solutions as a function of electrolyte composition, current density, illumination by an incandescent lamp or LGI-21 laser, and temperature. The starting solutions contained different component ratios as follows: 0.1 to 6 M SeO_2 + 1 to 9 M H_2SO_4 + 1 to 9 M HF. The electroprecipitation was performed either in darkness or under illumination at temperatures of 25 and 95°C. Polarization curves were recorded on an electrode produced by electrodeposition of selenium on platinum or stainless steel at a current density of 10 mA/cm² for 30 minutes. The reproducibility of the polarization curves near +300 mV from a stationary potential amounted to ± 10 mV and in the area greater than -1 it amounted to 0.1 V. As the negative potential values increased to 20-50 V, the error amounted to ± 4 V on one and the same electrode. At room temperature in all of the aforementioned solutions and current density intervals, amorphous selenium with a red-violet tint was released. The selenium coatings were produced with a low current efficiency owing to the predominant release of hydrogen and with properties that were difficult to reproduce. At high temperatures and high concentrations of selenium dioxide, sulfuric acid, and hydrogen fluoride (> 5 M), the coatings' quality and the current efficiency were practically the same as those of selenium coatings produced from sulfuric acid electrolytes. As the concentration of sulfuric acid was decreased (< 5 M) and that of hydrogen fluoride was increased (> 5 M) at 95°C, selenium coatings were formed that were black, adhered well to their substrate, were of even thickness, were free of pores and cracks, and had a resistivity of at least 10^9 - 10^{10} ohm-cm. The kinetics and properties of the coatings produced were greatly dependent on the electrode process conditions. Laser irradiation of the cathode significantly increased the current efficiency of the process and the rate at which coatings possessing the property of memory were formed and reduced polarization of the electrode resulting from its semiconductor properties. Even irradiation by a laser operating at low power levels resulted in current increases of 1-2 orders of magnitude. The selenium coatings produced under laser irradiation had a resistivity of at least 10^9 - 10^{11} ohm-cm. The resistivity of coatings produced under the effects of laser irradiation was approximately an order of magnitude less than that of selenium coatings produced in darkness or under the illumination of an incandescent lamp. It was hypothesized that production of amorphous high-ohm selenium coatings involves the formation and inclusion of complex oxyfluoroselenate impurities possessing acceptor properties. Illumination has virtually no effect on adsorption of fluoride ions but significantly increases the adsorption of oxide compounds, thereby changing the ratio of concentrations of fluorine impurity and oxygen in the coating and on its surface. The said change in the ratio of fluorine and oxygen on the coating's surface alters the number of electron generation centers determining the rate of the electrode process and nature of the polarization curves. Figures 7; references 13: 10 Russian, 3 Western.

Electrocrystallization of Thallium Oxides in an Alkaline Medium. Directed Electrosynthesis of Textured Tl_2O_3 Films

957A0381B Moscow ELEKTROKHIMIYA in Russian
Vol 30 No 2, Feb 94 (manuscript received 27 Jul 93)
pp 264-265

[Article by G.A. Tsirlina, S.Ye. Pronkin, F.M. Spiridonov, S.Yu. Vasilyev, and O.A. Petriy, Moscow State University imeni M.V. Lomonosov; UDC 541.138.2]

[FBIS Abstract] A quantitative study examined the effect of electrocrystallization conditions on the degree of predominate crystallographic orientation of textured Tl_2O_3 films by using a potentiostatic process resulting in standard conditions of crystal nucleation center formation and growth. The cell used to conduct the preparative electrolysis was designed to provide even distribution of current lines during the precipitation process. A plane cellular graphite working electrode with a visible surface of 2 to 4 cm^2 was placed symmetrically between two parallel platinum counterelectrodes with an area of 20-30 cm^2 . The electrosynthesis process was conducted in a solution of 0.25 N NaOH + 0.04 N Tl_2SO_4 . After completion of the electroprecipitation process, the electrode was removed from the solution, held in ethanol for 3-5 hours, and then air-dried for 10-12 hours. This was done to eliminate errors associated with retention of electrolyte and water in the pores of the material. In the interval $0.017 < E < 0.127$ V, the current efficiency equaled 100 +/- 1 percent. At more negative values of E , anomalously high current efficiencies (up to 110 percent) were recorded that were attributed to the formation of a mixed $Tl(I)$ - $Tl(III)$ oxide. Diffractograms of samples of film that had been separated from their substrate were recorded in a focusing three-frame camera-monochromator, and samples left on their substrates were analyzed by using a DRON-2 diffractometer. The crystal phases were identified on the basis of data published by McClune in 1989. Tl_2O_3 was identified as the main electrolysis product throughout the entire aforesaid range of potentials. Anomalous ratios of the intensities of the reflexes were observed that confirmed the predominance of the (100) orientation of the crystals in the precipitate. Data obtained by using the thickest films produced were used to determine the dependence of the degree of primary orientation of the crystals of the precipitate on potential. The resultant dependence is characterized by a peak near which reproducibility is lower than along either its ascent or descent. It was thus concluded that rather subtle control of texturing during the electroprecipitation of thallium oxide in a potentiostatic electrolyte process is indeed possible. Figure 1; references 14 (Western).

Study of the Growth of Anodic Oxide on Aluminum in an Oxalic Acid Electrolyte by Rutherford Backscattering Spectroscopy

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pp 374-377

[Article by V.F. Sarganov, Minsk Electronics Institute, Byelarus; UDC 620.198]

[FBIS Abstract] The kinetics of the growth of anodic aluminum oxide in an oxalic acid electrolyte was studied by Rutherford backscattering spectroscopy. Glass ceramic plates that had been coated with 2- μm -thick aluminum films by electron beam vacuum evaporation served as the study specimens. The electrochemical anodizing had been performed in a 0.4 M aqueous solution of oxalic acid with an anodic current density of 4 mA/cm^2 and an electrolyte temperature of 291 K. During the course of the electrochemical process, anodic potential was measured by a P-5827M potentiostat. The kinetics of anodic aluminum oxide growth were studied by preparing test specimens corresponding to the different states of the anodizing process beginning with the stage in which a barrier oxide film is formed and culminating in the period of steady oxide growth. All of the said samples were carefully rinsed in a continuous flow of deionized water, dried in a centrifuge, and then held in a thermostatically controlled chamber 423 K for 30 minutes. The Rutherford backscattering spectroscopy studies were performed on the experimental accelerator at Aarhus University. The analysis was performed in a "random" mode by sounding with $^4He^+$ ions with an energy of 2 MeV and with the ion beam aimed in a normal direction to the oxide surface. He^+ ions backscattered at a 161° angle to the direction of the ion probe were recorded by a surface-barrier detector with a 2.7203-keV-wide energy energy channel and a zero channel corresponding to an energy of 222.2 keV. During the Rutherford backscattering spectroscopy process, an ion current of 50.0 nA was used along with an integral charge of 20 μK . Software that had been specially developed at Aarhus University was used to make the numerical corrections in the results that were required for correct determination of the composition of the anodic oxide based on its two main components, aluminum and oxygen. The spectroscopy studies established that the composition of the anodic oxide undergoes changes throughout the anodizing process. At the outset of the period of formation of a barrier oxide film, the levels of aluminum and oxide in the anodic oxide correspond to the formula $Al_2O_{3.08}$. As the oxide grows, the ratio of oxygen atoms to aluminum atoms in the oxide increases. During the period of steady anodizing, when the anodic oxide film acquires a regular cellular-porous structure, the oxide's composition is described by

the formula $\text{Al}_2\text{O}_{4.85}$. It was concluded that during the process of growth of the anodic oxide, the relief of the oxide-aluminum interface increases and the distribution profiles of its main components (aluminum and oxygen) in the vicinity of the interface undergo a change that is originally triggered by the presence of anodizing electrolyte impurities in anodic aluminum oxide formed in an oxalic acid solution. The said impurities are oxyanion complexes of aluminum and carboxyl groups (COO^-) that by their very nature must increase the oxygen:aluminum ratio of the Al_2O_3 being formed. Figures 2, table 1; references 16: 6 Russian, 10 Western.

Spectral and Electrochemical Properties of Sputtered Polyaniline

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pp 378-381

[Article by V.F. Ivanov, O.L. Gribkova, and A.V. Vannikov, Electrochemistry Institute imeni A.N. Frumkin, Russian Academy of Sciences, Moscow; UDC 543.82:541.138]

[FBIS Abstract] Polyaniline films are of interest from the standpoint of their possible application in light filters with controllable light transmission and flexible conductive coatings. A study examined the possibility of producing polyaniline films by vacuum evaporation. The polyaniline used in the experiments was in powder form and was chemically synthesized. Specifically, it was synthesized at room temperature in a solution of aniline salt in 2 M of hydrochloric acid to which a solution of ammonium persulfate in 2 M of hydrochloric acid was added until an aniline:oxidizing agent molar ratio of 2:1 was achieved. A magnetic stirrer was used to mix the two starting solution as the ammonium persulfate solution was added to it. The resultant sediment was filtered off; rinsed with distilled water, acetonitrile, and ethanol, and then dried under a vacuum. The polyaniline was sputtered onto glass substrates that had been coated with a transparent conductive layer of SnO_2 . The polyaniline powder was sputtered from a quartz vessel that was heated by a tungsten winding from room temperature to 500-550°C and that had a residual pressure of 0.133×10^{-2} Pa. The sputtered layers were then protonated in 1 M of HCl and then measured. In addition, polyaniline was produced by electrochemical synthesis in a 1 M aqueous solution of hydrochloric acid with an aniline concentration of 0.1 M under potentiostatic conditions with a potential of 0.75 V. A saturated silver chloride electrode served as the standard electrode. Potentiodynamic measurements of the various forms of polyaniline were made with a PI-50-1 potentiostat and PR-8 programmer. All spectral measurements were made on a Beckman DU-7 spectrophotometer. The sputtered layers of polyaniline were gray-green, and its spectrum in air was reminiscent of that of the basic form of polyaniline. When the sputtered film was submerged in a hydrochloric acid solution, however, its absorption spectrum underwent a change in appearance that was attributed to protonation of

the sputtered film. Protonation of the sputtered polyaniline proceeded at a significantly slower pace than did that of the chemically and electrochemically synthesized polyanilines. This difference in protonation rates was attributed to the fact that the sputtered polyaniline has a denser structure than the chemically and electrochemically synthesized forms of polyaniline. Spectra of the optical absorption of the sputtered polyaniline films were obtained at potentials of 0.2, 0.4, 0.6, 0.8, and 1.0 V. The spectra were noticeably different from those obtained for the electrochemically synthesized polyaniline. The second stage of oxidation corresponding to the transition from emeraldin to pernigraniline was not observed in the sputtered layers of polyaniline. It was hypothesized that this difference was the result of some defect in the molecular structure of the sputtered polyaniline. Specifically, it was proposed that during the sputtering process, the macromolecules of polyaniline are torn into low-molecular-weight fragments that do not recombine correctly on the substrate but that instead form a defective structure in which the "head-to-tail" arrangement of monomer units that is characteristic of polyanilines produced by other methods is destroyed. Figures 4; references 14: 3 Russian, 11 Western.

Ultrasound-Stimulated Electroprecipitation of Copper in Channels of Narrow Openings. Arrhenius Dimensional-Cavitation Selectivity

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pp 403-405

[Article by Yu.V. Seryanov, L.M. Kvyatkovskaya, and V.A. Grishanin, Almaz State Scientific Production Enterprise, Saratov; UDC 621.357.7]

[FBIS Abstract] Previous experimental and theoretical studies of the ultrasound-stimulated potentiostatic precipitation of copper in metallized channels of dielectric boards demonstrated significant self-acceleration of the process in accordance with a hypothetical mechanism of cavitation superheating of the channel walls that was intensified by ultrasound-stimulated release of hydrogen. In accordance with those data, a sonoselectivity of the deposition of copper (K_c) was observed that may be calculated from the relationship of the density of the current in the opening (i_o) to the density of the current of ultrasound-stimulated release of copper on the board. It was further demonstrated that $K_c = i_o/i$, whereas the same coefficient for a process without ultrasound irradiation does not exceed 1. K_c was theoretically calculated by using the equation for cavitation electroprecipitation of metal for the case of precipitation of copper in the channel of an opening and on a board. The resultant theoretical analysis confirmed that an Arrhenius dimensional-cavitation selectivity effect is involved in the process of ultrasound-stimulated electroprecipitation of metal in narrow openings. The essence of the Arrhenius dimensional-cavitation effect was explained quite precisely by using an expression for the

temperature of the heating of the channel walls calculated from the average (absolute) temperature of the ultrasound-heated electrolyte. It was concluded from the said calculations that the maximum values of the average (absolute) sonoselectivity of copper deposition for processes controlled by diffusion-crystallization stages is between 3 and 6 versus approximately 10 for processes controlled by charge transfer and approximately 20 for processes controlled by a chemical stage. It was further concluded that in any case, the degree of selectivity is insufficient for ultrasound-stimulated maskless local electroprecipitation of metal in holes and that a cavitation-resistant protective mask must be used when implementing the said processes. The Arrhenius dimensional-cavitational effect discovered and the equation constructed for calculating it were said to also apply to processes of ultrasound-intensified electroforming, especially in cases where components with a characteristic size of $\Delta_0 \leq 1$ mm are being formed. Figure 1, table 1; references 6 (Russian).

Effect of Macrocycle Structure of Polymeric Aza-Crown Ethers on Stability of Gold Hydrosol

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received 26 Oct 93) pp 261-265

[Article by L. A. Tsarkova, A. P. Orleneva, A. A. Rakhnyanskaya, V. L. Lishchinskiy, N. V. Pertsov, and V. S. Pshezhetskiy, Moscow State University imeni M. V. Lomonosov, Moscow; UDC546.19:541.182]

[FBIS Abstract] One of the basic problems in modern colloid chemistry is controlling the stability of dispersed systems with high molecular compounds. Despite much work in this area, the relationship of the modifying action of polymers to chemical structure and macromolecular conformation in solution remains unclear, although realization of selectivity in many technological processes requires a high degree of selectivity in the modifying activity of reagents. Predicting the selectivity of chemisorption of a molecule on a particle surface for the purpose of altering its hydrophobic characteristics is an important problem from both the theoretical standpoint and for the practical selection of new reagents for fine control of interactions in dispersed systems. This type of research is especially needed to meet the growing interest in the properties of natural colloidal gold dispersions as applied to ore treatment. During flotation, a widely used method, losses occur due to unsatisfactory flotation of gold particles of less than 10 microns. Increasing the selectivity and efficiency of flotation could be achieved by selectively enlarging the colloidal particles into flotation-size aggregates. In the present

work dynamic light scattering was used to study the stability of gold hydrosols in the presence of aza-crown ethers of various structures immobilized on a polymeric matrix. It was demonstrated that the specificity of the reaction of polymeric trimethyl-tetraza-12 crown ether with ionic gold also holds for hydrosols of this metal. The flocculating activity of these polymeric reagents is determined by the composition of the macrocycle and the structure of the polymer matrix. The reactive crown ether group provides selectivity in the reaction of the macromolecule with the particles, while the structure of the adsorbed layer controls the inter-particle reactions and therefore affects the stability of the dispersed system. Figures 3; references 16: 12 Russian, 4 Western.

Study of Surface Properties of Ultra-Fine Diamonds

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in Russian Vol 56, No 2, Mar-Apr 94 (manuscript
received 18 Oct 93) pp 266-268

[Article by G. A. Chiganova, Krasnoyarsk Scientific Center, Krasnoyarsk; UDC541.183:666.233]

[FBIS Abstract] Many of the physical and chemical properties of diamonds are dependent on the composition and properties of their surfaces as formed during preparation and chemical treatment. The electrokinetic, ion exchange, and sorption properties of diamonds particularly are determined by the nature and quantity of surface functional groups. Carboxyl, carbonyl, hydroxyl, and other groups are known to form on the surface of diamond oxidized with oxygen and certain liquid oxidants. Ultra-fine diamonds made by detonation synthesis are subject to oxidizing agents even while leaching them out of the explosion products. Taking into account also the presence of an active highly developed surface on the ultra-fine diamond, it may be assumed that the method of separation from carbon impurities will have an effect on the nature and quantity of oxygen-containing functional groups, and therefore also on the surface properties of the ultra-fine diamonds themselves. In the present work macroelectrophoresis and potentiometric titration were used to determine and compare the electro-surface and adsorption properties of ultra-fine diamonds separated from reaction products obtained by the explosion method. An approximation of the composition and quantity of protonogenic functional groups on the diamond surfaces was determined. It was demonstrated that ultra-fine diamonds prepared by oxidation of non-diamond carbon with air oxygen are characterized as having a higher content of protonogenic groups, including carboxylic, and a higher electrokinetic potential and adsorption capacity. Figures 2; tables 2; references 7: 5 Russian, 2 Western.

Formation of Aluminum Titanate in Compositions with High Level of Spatially and Structurally Conjugated Components

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ORGANICHESKOY KHIMII in Russian Vol 64, No 4,
Apr 94 (manuscript received 5 Oct 93) pp 554-557

[Article by V. V. Gusarov, A. A. Malkov, A. A. Malygin, and S. A. Suvorov, St. Petersburg State Technological University; UDC541.127+541.128.7+541.124-16]

[FBIS Abstract] Rapid methods for synthesis of solid phase substances have attracted much attention recently due to low energy considerations and the possibility of obtaining substances having unique characteristics based on their original technological past history. An analysis of the causes of the slow rates of solid phase reactions at relatively low temperatures shows that in all cases the course of the reaction is conditioned by a single complex of causes. The elementary processes leading to phase formation may be subdivided into transport processes (diffusion and cooperative mass transfer) and transformational processes (nucleation and collective re-structuring). Solid phase diffusion and nucleation without nucleic sites are the slowest processes. One of the specifics of aluminum titanate synthesis lies in the fact that at the temperature range of its thermodynamically stable state, the initial components, i.e., the oxides of aluminum and titanium are in the corundum and rutile form and that they are significantly different in form from aluminum titanate and therefore are not capable of serving as nucleation sites. In the present work a study was made of the effects of the past history of the components and synthesis conditions on the rules governing phase formation in the system aluminum oxide-titanium(IV) oxide. Based on an analysis of factors determining the rate of a solid phase reaction, a method is proposed for rapid phase formation in the above system. It was demonstrated that synthesis of aluminum titanate under the given conditions goes practically to completion in 5 minutes at 1573 K. Figures 3; references 21: 12 Russian, 9 Western.

Solvation Enthalpy of Alkanes in Binary Non-Aqueous Mixtures

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ORGANICHESKOY KHIMII in Russian Vol 64, No 4,
Apr 94 (manuscript received 5 Jul 93) pp 576-578

[Article by D. V. Batov and V. P. Korolev, Chemistry of Non-Aqueous Solutions Institute, Ivanovo; UDC541.8.11]

[FBIS Abstract] The problem of describing the enthalpies of solvation and solution of alkanes in mixed solvents draws attention because of the unique role of the latter in chemical technology. Knowing the enthalpies of solvation of a hydrocarbon in the components of mixture, the problem comes down to being able to predict the enthalpy of solvation in the mixture. Theoretical and semi-empirical approaches, as developed for

individual solvents, encounter difficulties when used with mixed solvents owing to uncertainties in parameters such as dipole moments and polarity. Also, linear interpolation of enthalpies of solvation of alkanes as components of a mixture by composition fails to adequately describe experimental data. In binary non-aqueous mixtures the enthalpies of solvation and solution of hydrocarbons vary linearly with the density of cohesion energy r . In the present work a method is proposed that is based on linear interpolation of enthalpies of solvation of alkanes in individual solvents as components of a mixture by the coordinate of density of energy of cohesion of the mixed solvent r . Tables 2; references 12: 8 Russian, 4 Western.

Synthesis and Study of Mesomorphism of Compounds, Containing Diaminodibenzo-18-Crown-6

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ORGANICHESKOY KHIMII in Russian Vol 64, No 4,
Apr 94 (manuscript received 16 Mar 93) pp 665-672

[Article by O. B. Akopova and L. S. Shabyshev, Ivanovo State University; UDC547.27:547.53:532.783]

[FBIS Abstract] The advent of functional crown esters brought on the search for new liquid crystal compounds containing crown ester groups in their structures. Combining the unique properties of liquid crystals with the also unique properties of crown esters should lead to the appearance and expansion of polyfunctional applications of these new compounds. These compounds have been reported to be used as thermo-sensitive ion-conducting films. Liquid crystal cholesteric crown esters are being used as new sensory systems of the "guest-host" type. In the present work a new series of compounds containing the diamino-dibenzo-18-crown-6 group in their structure were synthesized. Their mesomorphic properties and the effects of cis- and trans-substitutions in the crown ester component on manifestation of the liquid crystal phase were also studied. It was established that three compounds of the series enter the nematic phase on heating and have an interval of existence at 50-80°C. Figures 3; tables 2; references 14: 3 Russian, 11 Western.

Free Radicals During Electrochemical Reduction of 1,4-Naphthoquinonediimines

957A0348D St. Petersburg ZHURNAL
ORGANICHESKOY KHIMII in Russian Vol 64, No 4,
Apr 94 (manuscript received 24 Nov 93) pp 676-679

[Article by R. Gavars, Ya. Stradyn, L. Baumanė, B. Turovska, and E. Lokmane, Latvian Institute of Organic Synthesis, Riga; UDC547.655.6:543.422.27]

[FBIS Abstract] In the search for new electron-acceptors, some naphthoquinone analogs of quinonediimines were synthesized, and for the purpose of making new surfactants for Langmuir-Blodgett single layers, some of these new compounds had surfactant groups in them. It was

found that in the transition from benzo- to naphthoquinonediimine structure, the electron-acceptor properties of the molecule diminishes, as characterized by a more difficult transfer of the first electron to the molecule. It was previously demonstrated that during electrochemical reduction of quinonediimines, not only primary anion-radicals but also secondary radicals could form, depending on the sequence and speed of addition of two electrons and two protons. In the case of 1,4-benzoquinonediisulfonyldiimines, secondary radicals, formed by protonization of primary anion-radicals, are relatively more stable, retain the quinone system of π -electrons, and are similar to the ion-radical layer in which a metal cation is displaced by a proton. The radical layers of a quinone structure could possess an elevated electrical conductivity at low temperatures. In the present work a study was made of the possibility of forming similar radicals for the newly synthesized 1,4-naphthoquinonediimines using the EPR method. During electrochemical reduction of N,N'-disulfonyl-N,N'-dicarbonyl- and N-sulfonyl-N'-carbonyl-1,4-naphthoquinonediimines in acetonitrile, anion-radicals of the initial molecule are formed and, unlike the anion-radicals of N,N'-sulfonyl-1,4-benzoquinonediimines, they are incapable of protonization into stable free radicals. The latter is evidently due to the unfavorable steric configuration of electron pairs in the imine nitrogen atom. Table 1; references 14: 9 Russian, 5 Western.

Electrochemical Treatment With Microsecond-Range Pulses

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Vol 30 No 4, Apr 94 (manuscript received 25 Feb 93)
pp 490-498

[Article by A.V. Rybalko and A.I. Dikumar, Applied Physics Institute, Republic of Moldova Academy of Sciences, Kishinev; UDC 621.9.047.7;541.13]

[FBIS Abstract] In electrochemical machining and electrochemical processes, using electric pulses makes it possible to achieve a much higher degree of precision when manufacturing metal products with complexly shaped surfaces than is possible when a constant current is used. Past experience with pulsed electrochemical machining has indicated that reducing the pulse duration to the microsecond range while increasing the amplitude density of the current in the pulses opens up a whole new range of possibilities from the standpoint of improving the precision and localization of machining. The said possibilities were explored in a study involving the use of a cell with a plane-parallel gap that was varied between 0.1 and 2 mm. The cell had a hydrodynamic channel of 110 mm with a width of 10 mm. The electrodes were placed flush with the channel walls at a distance of 50 mm from the entrance. A graphite electrode with a surface area of 10 x 20 mm served as the cathode. The anode had a surface area of 4 x 10 mm. The pressure of the electrolyte at the entrance to the cell was kept at 2×10^5 Pa. As a power source, a specially

developed generator of bipolar rectangular pulses was used that made it possible to supply both single pulses and series of pulses to the interelectrode gap. Different concentrations of NaCl and NaNO₃ solutions were used. Most of the experiments involved anodic dissolution of 12Cr18Ni9Ti steel and refractory chromium-nickel alloys such as KhN77TYuR and ZhS6KP. The use of microsecond-range pulses permitted dissolution at high current densities in the pulse (on the order of 10^3 A/cm and greater) and control of the localization of anodic dissolution by altering the ratio of the current's Faraday and non-Faraday components. Use of a counterpulse in the pause between anodic current pulses made it possible to reduce the potential relaxation time and increase the speed of electrochemical machining while maintaining its localizing properties. It was concluded that when the pulse parameters and pause durations of pulsed electrochemical shaping processes are specified in accordance with the characteristic features of electrode processes under nonstationary conditions, they may be used for other electrochemical machining tasks as well, including deburring, marking, and broaching. Figures 14; references 24: 20 Russian, 4 Western.

Controlled Anodic Dissolution of Multilayer Metallic Structures by Gradually Changed Current

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pp 523-525

[Article by V.P. Lukovtsev, V.S. Borovkov, A.V. Dribinskiy, V.N. Uryev, and V.Ye. Kazarinov, Electrochemistry Institute imeni A.N. Frutkin, Russian Academy of Sciences, Moscow; UDC 541.138.2]

[FBIS Abstract] A method has been developed for successive dissolution of layers of metal and alloy by gradually changing the amplitude of the anodic current as the structure's successive layers are dissolved. The proposed method was tested in experiments entailing the anodic dissolution of 0.5- to 15- μ m-thick layers of copper and copper-tin alloy on a 3-mm-diameter electrode in a sulfate electrolyte. A current of 15 mA was used to dissolve the copper, and the electrode's potential was established at a level of 250-300 mV in relation to the potential of the copper in the same solution. A current of 1.5 mA was used to dissolve the alloy, and the electrode's potential was set at a level of 50-60 mV. In the experiments, the potential (E) of the dissolved layer was considered a variable that is controllable by the following algorithm for controlling the two currents (I and I') responsible for dissolution of the given multilayer structure: If the first layer to be dissolved is an alloy layer, it is dissolved by the current I , in which case the electrode acquires a potential of E_1 . Because the anodic dissolution of the subsequent layer at a current of I' occurs at a higher potential (E_2), the alloy dissolves rather evenly and completely. Afterward, the electrode's potential increases to E_2 , at which point anodic dissolution of the layer of pure metal begins. The establishment of the electrode's potential at the level E_2 serves

as a signal to switch to dissolution by the current I' (the current is switched by the appropriate automatic device), at which point dissolution of the metal layer occurs at a potential of E''_2 . The said layer dissolves completely because at a current of I' , the alloy under it cannot be in an active state. Consequently, after the metal layer has dissolved, the electrode's potential begins to shift rapidly to the anodic direction. This shift in turn serves as a signal to switch to dissolution by the current I , in which case both metals are in an active state, etc. The time intervals specified by a time programmer based on the principle of successive dissolution of metal layers may be read by either the time for which the electrode's potential is at the levels E'_1 and E''_2 or the time for which the controlling current is at the levels I and I' . The proposed method was said to be suitable only for those pairs of metal layers with different electrochemical activities in which the more electronegative metal (the more electrically active layer) has a narrower range of active anodic dissolution currents. The experiments performed confirmed that a device that is based on a time program and that contains a data carrier in the form of a multilayer metallic structure may be made to operate reliably by using the proposed controlled anodic dissolution method and algorithm. Figures 2; references 2: 1 Russian, 1 Western.

Controlled Anodic Dissolution of Multilayer Metallic Structures by Gradually Changing Voltage

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pp 526-528

[Article by V.P. Lukovtsev, V.M. Grafov, A.V. Dribinskiy, V.S. Borovkov, and Ye.A. Nizhnikovskiy, Electrochemistry Institute imeni A.N. Frutkin, Russian Academy of Sciences, Moscow; UDC 541.138.2]

[FBIS Abstract] Virtually all electrochemical timers and time programmers are based on a process of anodic dissolution of an electrically active substance on an inert substrate, with a known quantity of constant current serving as the control effect. One significant drawback of the said technique is that in the final state of dissolution, when the percentage of the electrode surface that is coated with the electrically active substance decreases, passivation of the incompletely dissolved part of the active layer may occur and result in a significant increase in the electrode's potential. Besides resulting an increase in the error in reading time intervals, the said phenomenon is extremely undesirable in devices in which the data carrier has been designed in the form of a set of thin alternating layers with different levels of electrochemical activity. As a way of solving this problem, it has been proposed that time delays be specified by feeding a specified potential to the working electrode. The time intervals can then be read on the basis of the characteristic change in current confirming the end of anodic dissolution of the working mass of the electrically active material. A significant drawback of the latter technique

from the standpoint of its possible use in electrochemical timers and time programmers is the effect that extraneous factors have on the rate of the electrochemical reaction of anodic dissolution. As a solution to this problem, a method has been proposed that calls for successively dissolving alternating layers of metal and alloy by gradually changing the voltage as each layer is dissolved. The proposed method was tested on an electrochemical system consisting of copper and tin. The experiments were performed with a 3-mm-diameter copper electrode. A technique was developed for controlling the voltage of the anodic dissolution process so that the rate at which each layer dissolved would be significantly faster than the rate at which its substrate dissolved. The control method was illustrated by way of the example of a metal and alloy system in which one of the two layers was significantly more electrically active than the other. The process was determined to proceed as follows: The electronegative layer (the alloy) dissolves at a lower potential (designated E') than the layer of pure metal. It dissolves completely on account of the lower activity of the subsequent layer ($I_1 > I_2$). The electropositive layer (the pure metal) dissolves when a higher potential (designated E'') is fed to the electrode. The said layer dissolves completely because the electronegative layer lying under it cannot be in an active state given the potential E'' and $I'_2 > I'_1$. The abrupt increase in current that occurs upon the transition from one layer to the next (from I_1 to I_2 and from I'_2 to I'_1) in turn serves as a signal to change the magnitude of the control effect (from E' to E'' and from E'' to E' , respectively). Unlike the method of controlling the anodic dissolution of multilayer metallic structures by gradually changing the current, which necessitates that the critical rate of electrochemical dissolution of the electronegative layer be much lower than that of the electropositive layer, the method of controlling anodic dissolution based on gradually changing voltage does not entail any such restriction. The said method does not require a lower maximum rate of active dissolution of the electronegative layer. Figures 3; references 6 (Russian).

Ceramic Materials from Zirconium Dioxide

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[Article by L. V. Morozova, V. V. Ivashkin, and V. B. Glushkova, Silicate Chemistry Institute imeni I. V. Grebenshchikova, St. Petersburg; UDC 541.165/546.831]

[FBIS Abstract] Progress in many branches of technology hinges on development of new structural materials having special properties. Presently, ceramics occupy a special place among such promising materials due to their unique chemical and physical properties, such as being chemically inert, resistant to heat, and high in strength and hardness. The system ZrO_2 - Y_2O_3 - MgO is especially interesting from the standpoint of developing

ceramics outstanding in heat resistance, kinetic stability, and high mechanical properties. It is known that the mechanical properties of ceramics made from stabilized zirconium dioxide may be altered by thermal treatment in the sub-eutectoid zone or by so-called sub-eutectoid aging. In the present work a study was made of the above system and the results make it possible to recommend this material in various branches of technology as a structural ceramic capable of a sustained long-term service life at 900° and a short-term life at temperatures as high as 1200°. Figures 2; tables 2; references 5: 3 Russian, 2 Western.

Development of Expert System 'Structural Materials'

957A0326B St. Petersburg ZHURNAL PRIKLADNOY KHIMII in Russian Vol 67, No 7, Jul 94 (manuscript received 28 Feb 94) pp 1110-1115

[Article by V. V. Avseyev, A. M. Bessarabov, A. M. Yaroshenko, G. Z. Blyum, and R. M. Malyshev, Chemical Reagents and Ultrapure Chemical SRI, Moscow; UDC681.322:54-41]

[FBIS Abstract] Development of many areas in science and technology requires having a broad supply of information for research, experimental construction operations, and the development of modern advanced technology guaranteeing production which is competitive on the world market. Lack of information is especially acute in high priority areas such as micro-electronics and optics where any lagging from the world level cannot be tolerated. Since progress in these areas depends largely on the level of production in the chemical industry, a stream of the most diverse information must be directed to this direction. Problems in the technology of chemical reagents are very complex and all factors must be taken into account to provide success in resolving them. One of the most important factors is selection of structural materials and items made of them. Solution to this problem is possible only with a modern system of information. A special feature of the developed data base "Structural Materials" is the presence of information on chemical, mechanical, physical, and other parameters of structural materials. Information is also available on the polluting effects of structural materials in contact with ultra-pure liquids. The next element is the characteristics of the surface layer or surface topography of the material, and a very important characteristic is the possibility of cleaning it. The data base includes information on the interactions of structural materials with various environments (up to 50 names). In the present work this data base was used to develop a demonstration prototype of an expert system whose basic task is to imitate the behavior of an expert in analyzing the properties required for a given application of a structural material and then search for them in the data base. Tables 7; references 9: 8 Russian, 1 Western.

Study of Reaction of Diamino-Dihypophosphitocuprate(II) with Surfaces of Modified Dielectrics

957A0326C St. Petersburg ZHURNAL PRIKLADNOY KHIMII in Russian Vol 67, No 7, Jul 94 (manuscript received 23 May 94) pp 1139-1142

[Article by L. A. Pavlyukhina, G. V. Odegova, and T. O. Zaykova, Solid Body Chemistry and Mineral Ore Refining Institute, Novosibirsk; Catalysis Institute, Novosibirsk; UDC686.4]

[FBIS Abstract] Direct thermal or photochemical deposition of metals on solid carriers is interesting from the standpoint of developing new technologies for producing electrically conducting coatings for printed circuits and flexible printed cables, metalized templates on transparent polymers, and new photomaterials, as well as new highly active catalysts. These processes use complex chemical compounds and take place at the solid-gas interface (vapors of a volatile metal complex) or at the solid body-metal complex solution interface. The latter so-called solid body activation of dielectric surface process is the least studied. In the present work electron spectroscopy of diffused reflected light was used to study the effects of organic additives and the chemical nature of the substrates on the structure and composition of deposited diamino-dihypophosphitocuprate(II) complex. Varying the nature of the solid surface and addition of organic additives to the activating solution of the metal complex causes a significant effect on the status of the amino-complex sorbed on the substrate, especially in thin layers. The organic additives distort the structure of the sorbed complex by displacing water molecules located in the second coordination sphere. The surface interacts with the structure of the copper(II) complex bound to it further enhancing the distortion of its structure. Figures 3; references 3 (Russia).

Carbon Adsorbents from Solid Fuel Refining Products

957A0326D St. Petersburg ZHURNAL PRIKLADNOY KHIMII in Russian Vol 67, No 7, Jul 94 (manuscript received 23 Feb 93) pp 1207-1211

[Article by Yu. V. Pokonova and A. I. Grabovskiy, St. Petersburg Technological Institute; UDC661.183.123]

[FBIS Abstract] One of the most pressing problems facing further expansion in the production of adsorbents lies in the search for new binders capable of effectively replacing traditional wood tar, which is becoming scarce. Research has been conducted on the use of petroleum and shale residues as binders in the preparation of carbon adsorbents. In the present work a study was made of the effects of the nature of the binder on the pore structure, strength index, and sorption characteristics of these adsorbents. Shale phenols (mixture of alkylresorcinols) or their solutions in technical grade furfural yield carbon adsorbents having high mechanical strength (up

to 97 percent), high microporosity (to $0.41 \text{ cm}^3 \text{ per cm}^3$, and higher sorption capacity. Medium charred samples have higher selectivity in leaching out noble metals from multi-component polymetallic solutions than those formed from traditional wood tar. In these specifications, they also exceed industrial adsorbents. Low charred samples have high selective and separating properties for gaseous mixtures. Tables 4; references 4: 3 Russian, 1 Western.

Liquid-Vapor Equilibrium in Binary Systems Based on Arsenic Trichloride. 4. Systems Formed by Arsenic Trichloride and Selected Chloroalkenes

957A0468A Moscow VYSOKOCHISTYYE VESHCHESTVA in Russian No 5, Sep-Oct 94 (manuscript 31 Mar 94) pp 75-78

[Article by Ye.A. Yushina, V.A. Fedorov, V.A. Yefremov, L.N. Kazanskiy, V.Ye. Trokhin, S.V. Nikolashin, A.A. Yefremov, and T.K. Menshchikova, General and Inorganic Chemistry Institute imeni I.S. Kurnakov, Russian Academy of Sciences, Moscow, and Chemical

Reagents and High-Purity Chemicals Institute, Moscow; first paragraph is VYSOKOCHISTYYE VESHCHESTVA abstract; UDC 546.19.131.542.46]

[FBIS Translated Text] *The results of an experimental study of liquid-vapor equilibrium in binary systems formed by arsenic trichloride and tetrachloroethane, trichloroethene, cis-1,2-dichloroethene, and 1,1-dichloroethene are presented.*

When arsenic trichloride is formed by the unconventional method, which is to say when chemical weapons (lewisite) are detoxified by the method of chlorination,¹ chloroalkenes are formed in addition to the chloroalkanes specified elsewhere.² The amount of these impurities in arsenic trichloride isolated by distillation from lewisite's chlorination products is significant, i.e., 23-36 percent by weight (Table 1). They include the following impurities, which have boiling points close to the normal boiling point of arsenic trichloride (normal boiling point, 130.1°C): 1,1,2-trichloroethane; 1,1,2,2-tetrachloroethane; and especially tetrachloroethene (normal boiling point, 120.8°C).

Table 1. Amount of Organochlorine Impurities in Arsenic Trichloride Separated From Products of the Detoxification of Lewisite by Chlorine Gas

Organochlorine compounds	Normal Boiling Point, $^\circ\text{C}$	Amount, percent weight
1,2-Dichloroethane	84.0	1.0-2.0
1,1,1-Trichloroethane	74.1	1.5-2.5
1,1,2-Trichloroethane	113.9	4.0-5.0
1,1,2,2-Tetrachloroethane	145.9	6.5-10.5
Pentachloroethane	160.5	3.0-5.0
cis-1,2-dichloroethene	60.3	1.5-2.0
1,1-Dichloroethene	31.7	2.5-3.0
Trichloroethene	86.7	2.0-4.0
Tetrachloroethene	120.8	1.0-2.0

Designing a process of rectification separation of commercial-grade arsenic trichloride (98.7-99.7 percent by weight) and eventually obtaining high-purity arsenic trichloride from it requires knowing the liquid-vapor equilibrium of arsenic trichloride-impurity systems. Other publications²⁻⁴ have presented data for systems formed from arsenic trichloride and arsenic alkylchlorides, acetyl chloridem and chloroacetyl chloride, and chloroalkanes. This communication presents the results of a study of the liquid-vapor equilibrium of binary systems formed from arsenic trichloride and the following chloroalkenes: tetrachloroethene ($\text{Cl}_2\text{C}=\text{CCl}_2$), trichloroethene ($\text{ClHC}=\text{CCl}_2$), cis-1,2-dichloroethene ($\text{HCIC}=\text{CHCl}$), and 1,1-dichloroethene ($\text{Cl}_2\text{C}=\text{CH}_2$).

Liquid-vapor equilibrium was studied in a broad concentration interval by the ebulliometric method on a

Sventoslavskiy instrument. A Van-Laar equation was used to process the data obtained in the experiments. The pressure of the saturated vapor of arsenic trichloride was assumed to equal that presented elsewhere,⁵ and the saturated vapor of the chloroalkenes was assumed to equal that presented in another source.⁶ As elsewhere,³ the starting materials were purified by rectification on a column with an efficiency of 100 theoretical stages of separation. Chromatographic analysis established that the tetrachloroethene, trichloroethene, cis-1,2-dichloroethene, and 1,1-dichloroethene each had a purity of least 99.9 percent by weight and that the metal impurities contained in each amounted to 10^{-6} - 10^{-7} percent by weight. The separation coefficients (α) were determined experimentally on a Bushmak-in-type device with direct chromatographic analysis of the composition of the liquid and vapor equilibrium phases.

Table 2. Liquid-Vapor Equilibrium of Arsenic-Chloroalkene Binary Systems at a Pressure of 740 torr

Chloroalkene	Composition, Mole Fraction of Chloroalkene		Boiling Point, °C
	Liquid	Vapor	
Tetrachloroethene	0.105	0.169	125.8
	0.260	0.335	123.4
	0.500	0.550	121.2
	0.740	0.760	120.0
	0.910	0.915	119.9
Trichloroethene	0.090	0.351	118.8
	0.240	0.402	108.8
	0.378	0.720	102.4
	0.502	0.790	98.2
	0.648	0.868	96.6
	0.781	0.925	90.1
	0.900	0.969	87.1
<i>cis</i> -1,2-Dichloroethene	0.180	0.720	98.8
	0.350	0.852	84.0
	0.500	0.910	75.2
	0.652	0.946	68.6
	0.803	0.973	64.8
	0.904	0.988	62.5
1,1-Dichloroethene	0.150	0.834	77.9
	0.348	0.909	59.6
	0.503	0.960	49.7
	0.681	0.983	41.4
	0.868	0.994	35.0

Table 2 and Figure 1 present the experimentally obtained and calculated results. All of the systems have positive deviations from the ideal and are irregular in view of the asymmetric course of the concentration dependence of the activity coefficient of their components. For binary solutions based on arsenic trichloride, the coefficients A and B in the Van Laar equation are as follows: tetrachloroethene, $A = 0.088$ and $B = 0.211$; trichloroethene, $A = 0.079$ and $B = 0.176$; *cis*-1,2-dichloroethene, $A = 0.121$ and $B = 0.225$; and 1,1-dichloroethene, $A = 0.155$ and $B = 0.258$.

The positive deviations from the ideal for solutions of chloroethenes in arsenic trichloride result in an elevation of the distribution coefficient α in the range of low chloroalkene concentrations. For tetrachloroethene, which has the boiling point closest to that of arsenic trichloride, the separation coefficient in the range of low chloroalkene concentrations is $\alpha = 2.07$ as compared with $\alpha_{ideal} = 1.28$. The high separation coefficient values obtained in the range of low amounts of chloroethenes when $\chi_2 \rightarrow 0$ (χ_2 being the amount of chloroethene contained in the arsenic trichloride) confirms the effectiveness of purification of the remaining chloroethenes from arsenic trichloride. The value of α when $\chi_2 \rightarrow 0$ was determined based on the ratio $\alpha = \alpha_{ideal}\gamma_2$, where $\ln \gamma_2 = B$. The following values were

obtained for diluted solutions of the following: trichloroethene, $\alpha = 5.4$; *cis*-1,2-dichloroethene, $\alpha = 14.1$; and 1,1-dichloroethene, $\alpha = 22.5$.

References

1. I.B. Yevstafyev, ZHURN. VSESOUYUZ. KHIM. O-VA IM. D.I. Mendeleeva, Vol 35, No 4, 1990, p 486.
2. Ye.A. Yushina, V.A. Fedorov, A.A. Yefremov, VYSOKOCHISTYYE VESHCHESTVA, No 5, 1993, p 65.
3. Ye.A. Yushina, V.A. Fedorov, Ye.Ye. Grinberg, Ibid., No 4, 1993, 102.
4. Ye.A. Yushina, V.A. Fedorov, A.A. Yefremov, Ibid., No 2, 1994, p 57.
5. L.A. Niselson, T.D. Sokolova, ZHURN. NEORGAN. KHIMII, Vol 10, 1965, p 592.
6. Ye.A. Treger, I.F. Pimenov, Ye.A. Golfand, Spravochnik po fiziko-khimicheskim svoystvam khloralifaticheskikh soyedineniy (Manual on Physicochemical Properties of Aliphatic Chlorine Compounds), Khimiya, Leningrad, 1973, p 69.

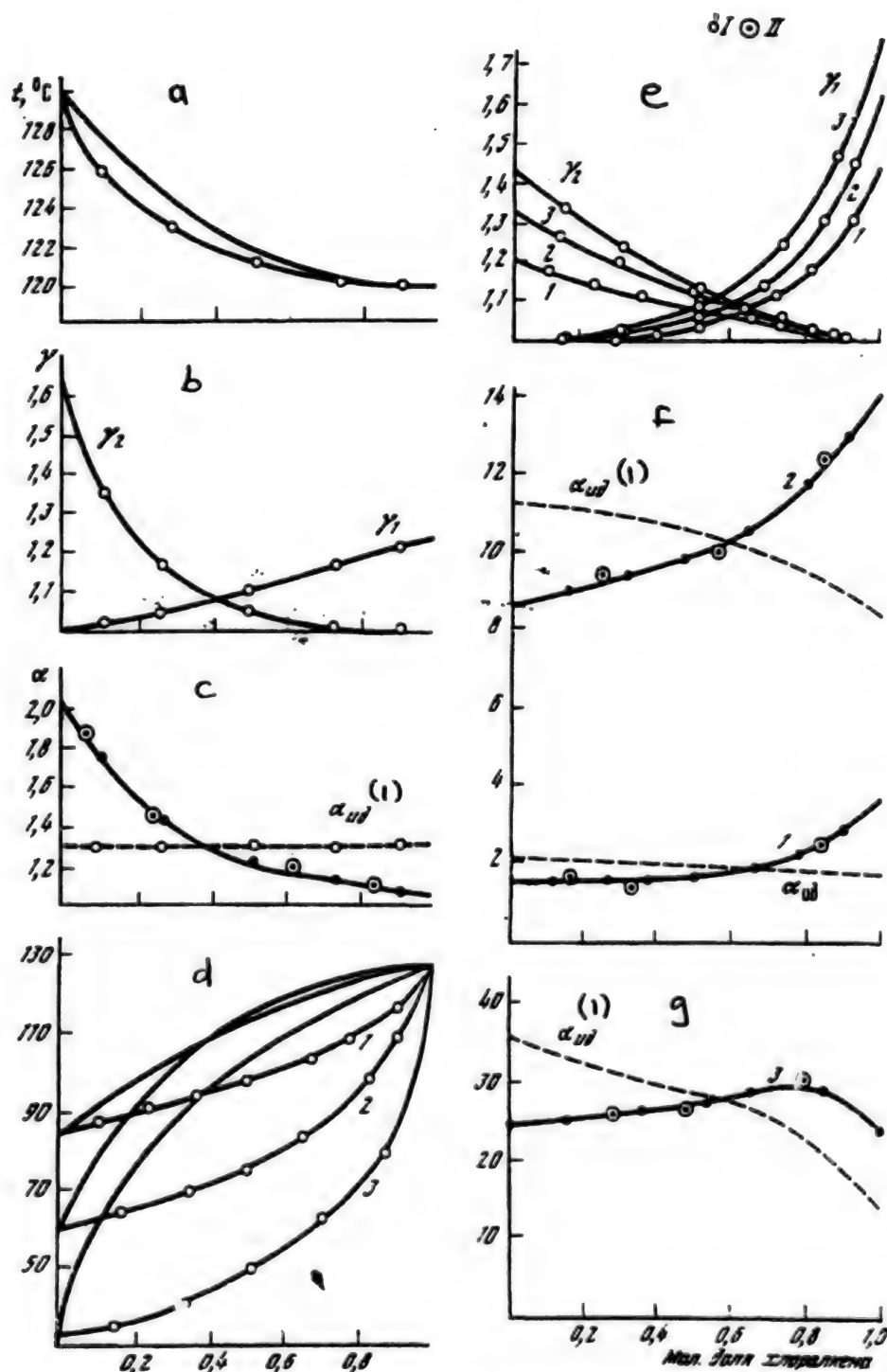


Figure 1. Liquid-vapor equilibrium in the following systems: a, b, c = $\text{AlCl}_3\text{-Cl}_2\text{C=CCl}_2$; d, e, f, g = 1, $\text{C}_2\text{HCl}_3\text{-AsCl}_3$; 2, $\text{cis-1,2-C}_2\text{H}_2\text{Cl}_2\text{-AsCl}_3$; 3, $\text{C}_2\text{H}_2\text{Cl}_2\text{-AsCl}_3$. Data were obtained as follows: I, on a Sventoslavskiy instrument; II, on a Bummakin instrument; a and d, boiling point-composition diagrams; b and c, coefficients of the activity of $\gamma_1\text{-AsCl}_3$ and $\gamma_2\text{-chloroalkene}$; c, f, and g, separation coefficients. Mole fractions of chloroalkene are plotted along the x-axis of each graph; (1) = α_{ideal} .

Concept of Improving the Quality of the Drinking Water in Ukraine

957A0358A Kiev *KHIMIYA I TEKHOLOGIYA*
VODY in Russian Vol 16 No 5, Sep-Oct 94 pp 467-472

[Article by V. V. Goncharuk]

[FBIS Abstract] Ukraine is encountering serious difficulties in supplying its residents with safe drinking water on account of the sharp increase in pollution of its main water sources by nitrates, phosphates, heavy metals, petroleum products, pesticides, radionuclides, and pathogenic microorganisms. The extensive amounts of chlorine now used to purify drinking water are only exacerbating the problem. Ukraine lacks the equipment and raw material base to use more progressive water purification processes such as those involving ozonization and ion exchange. In view of these facts, a comprehensive plan for improving the quality of Ukraine's drinking water must be developed. The said plan should emphasize the extreme importance of protecting Ukraine's water basin from further contamination and should include provisions for the following: immediate introduction of a set of economic, legal, and scientific-technical measures to protect Ukraine's water basin; reserve uncontaminated well waters for use as a source of drinking water; improve the efficiency of existing water preparation processes and develop and introduce fundamentally new processes based on the latest scientific and technical progress; develop and introduce efficient individual-use and collective-use water purifiers; create water purification systems and devices for use in agriculture; and create the body of laws and standards required to ensure implementation of the aforesaid provisions. The combination of the increased anthropogenic load that has been placed on Ukraine's water bodies in recent years as a result of industrial production and the accident at the Chernobyl Nuclear Power Plant and the simultaneous failure to fulfill plans for constructing new water treatment facilities and failure to implement planned water quality improvement measures on time because of the country's economic difficulties has created a situation where much of Ukraine's drinking water is a health hazard. The economic concerns that have delayed measures to improve the quality of Ukraine's drinking water must be weighed against the biological and medical effects of contaminated water on the human body. A number of specific measures related to each of the aforesaid policy provisions have been proposed. Included among them are the following: construction of special enterprises for series production of local and large water treatment equipment to neutralize industrial and municipal sewage; creation of a special service that would transport, erect, service, and monitor the operating efficiency of the said factor-produced sewage treatment equipment; development/introduction of a system for monitoring, analyzing, and forecasting the condition of surface water and ground water; handling the problem of toxic industrial wastes at the national level; creation/introduction of a system and subdepartments capable of

rapid response to the accidental dumping of ecologically hazardous substances; expansion of the search for new sources of drinking water; classification of Ukraine's large underground water intakes to make it possible to develop measures to protect them and optimize their use; creation and commercial use of a process to preserve and package well water for drinking purposes; development/introduction of modern processes to produce quality drinking water by using ozone and hydrogen peroxide instead of chlorine; develop filters to remove suspended substances and microorganisms from drinking water; creation of new prototype home water filters; creation of a series of low-capacity modular water supply stations; development of the economic mechanisms required to ensure that the quality of existing water resources will be improved and protected from further contamination; determining who in Ukraine is to be solely in charge of managing Ukraine's water resources and guaranteeing that the public has quality drinking water; revision of existing standard No. 2874-82, which specifies water hygiene and quality control requirements; and provision of the required technological, metrologic, financial, and material-technical support to enforce new standards and rules for designing and redesigning existing water treatment facilities and constructing new ones.

Effect of Chlorination Process on the Quality of the Drinking Water in Kiev

957A0358B Kiev *KHIMIYA I TEKHOLOGIYA*
VODY in Russian Vol 16 No 5, Sep-Oct 94 (manuscript received 20 Jun 94) pp 472-479

[Article by M. Khoffmann and V. P. Mikhaylenko, Environmental Studies Laboratory, Kiev University imeni Taras Shevchenko; UDC 543.38+628.191]

[FBIS Abstract] Approximately 70 percent of the drinking water supplied to Kiev's residents and most of the city's industrial enterprises comes from the Dnepr River. The Dniester River and artesian wells account for the rest of the drinking water consumed by Kiev residents. The chlorination process has resulted in a sharp deterioration in the quality of Kiev's drinking water. Studies have established that both the hot and cold water supplied to Kiev's residents is contaminated with organic chlorine compounds. Gas chromatography does not yield a complete picture of the quantitative and qualitative profiles of the by-products resulting from chlorination; nevertheless, it does yield a rather accurate platform for making refined estimates of the amounts of organochlorine compounds present in the city's drinking water. The amounts of organochlorine compounds that have been established in Kiev's drinking water are so high that the fluctuations in the levels of organochlorine compounds from 500 to 250 µg/l or even 100 µg/l that were recorded in the beginning of 1994 cannot alter the fact that organochlorine compounds pose a health risk for Kiev's residents. The European Economic Community's established standard for organochlorine compounds is two orders of magnitude lower (1 µg/l). Boiling

cannot totally remove the toxic substances present in water as a result of chlorination because no one knows what more toxic and hazardous compounds could be spontaneously synthesized during the boiling process. Specifically, it is clear from analyses of samples of Kiev's drinking water analyzed between November 1993 and February 1994 that the city's water treatment plants are not functioning as a barrier between water-soluble organic compounds, especially phenols, and Kiev's residents. Published studies have demonstrated the staged formation of chlorophenols and polyatomic phenols under the effect of active chlorine. Yet other studies have demonstrated the further transformation of chlorinated compounds such as 2,4,5-trichlorophenol and 1,2,4,5-tetrachlorobenzene into extremely hazardous toxicants such as dioxins. Boiling therefore cannot be recommended as a way of treating water in the home. Even the hot water used when taking a shower or bath places Kiev's residents at risk of ingesting highly toxic chlorophenol compounds via inhalation. Table 1; references 12: 7 Russian, 5 Western.

Medical and Biological Aspects of Drinking Water Quality

957A0358C Kiev *KHIMIYA I TEKHOLOGIYA VODY* in Russian Vol 16 No 5, Sep-Oct 94 (manuscript received 15 Jul 94) pp 479-487

[Article by V.V. Goncharuk and S.S. Stavskaya, Colloid Chemistry and Water Chemistry Institute imeni A.V. Dumanskiy, Ukrainian Academy of Natural Sciences, Kiev; UDC 628.1.033]

[FBIS Abstract] The Drinking Water program is a program of research aimed in two directions: 1) monitoring biological contamination and developing measures to remove contaminants from water and 2) using organisms to cleanse undesirable impurities from water. Within the framework of the Drinking Water program, scientists at the Colloid Chemistry and Water Chemistry Institute imeni A.V. Dumanskiy examined the idea of switching a number of population centers throughout Ukraine, above all Kiev, to drinking water supplied from underground water sources. Although underground water is free of the contaminants present in much of Ukraine's surface waters because of environmental pollution, the use of water obtained from artesian wells involves its own specific set of problems, the main ones being primary and secondary biological and chemical contamination. Because artesian well waters lie deep below the earth's surface, they are not affected to any significant degree by surface precipitation or runoff. They are generally free of suspended substances; however, they may be mineralized, in which case their chemical composition will depend on the rock surrounding them. The artesian water now being used in Kiev is generally of high quality in and of itself; however, it is being used to replenish the city's tap water supply system. Furthermore, the quality of artesian water has been demonstrated by studies performed at the Hydrobiology

Institute of the Ukrainian Academy of Natural Sciences to vary greatly from well to well and to be largely dependent on the technical condition of the individual well. One serious problem is contamination of the water by ammonia compounds. In several of Ukraine's oblasts (Khmelnitskiy, Rovno, and Volyn), the average level of ammonia salts in underground waters is two to four times above the maximum level established for drinking water (2 mg/l). The presence of ammonia ions in water is due mainly to microbial destruction of proteins after the death of water organisms and phytoplankton that get into the water through municipal and industrial sewage and surface runoff (especially in agricultural areas). Studies performed at the Microbiology and Virology Institute imeni Academician D.K. Zabolotnyy of the Ukrainian Academy of Natural Sciences have demonstrated the possibility of using bacteria and a modular unit to remove ammonia, nitrates, and iron from water and thereby render it safe to drink. The process is based on oxidation of the ammonia by nitrifying bacteria. Various types of nitrifying bacteria may be used. All are autotrophic, which means that they do not require organic carbon. The denitrification process has been demonstrated to reach peak efficiency at nitrate levels of <100 mg/l, and oxidation of iron was found to be most efficient when it was present in concentrations under 10 mg/l. Scientists at the Microbiology Institute imeni Academician D.K. Zabolotnyy have also developed and manufactured a prototype unit to eliminate ammonia from water by means of nitrifying bacteria that was used successfully on water from the city of Khmel'nitskiy with an ammonia ion concentration of 5-6 mg/l. Other research projects that are being conducted at the Colloid Chemistry and Water Chemistry Institute imeni A.V. Dumanskiy for the purpose of making water acceptable for drinking include a study investigating the possibility of using various disinfectants in combination with ultraviolet light to treat water, a study of the safety of home water filters, and a study examining the possibility of using various fibrous materials as potential carriers in systems to remove microorganisms and organic and inorganic impurities from surface waters. References 15: 10 Russian, 5 Western.

Solubility of Ferrocenyldimethyl Carbinol and Ferrocenes in Different Gasolines and in Their Components

957A0327A Moscow *NEFTEKHIMIYA* in Russian Vol 34 No 6, Nov-Dec 94 (manuscript received 3 Jun 94) pp 557-561

[Article by Ye.A. Demyanenko, V.D. Matveyev, I.V. Statsenko, V.P. Tverdokhlebov, and V.A. Fedorov, Siberian Technological Institute, Krasnoyarsk; UDC 541.8:541.132]

[FBIS Abstract] A study examined the polythermal dependence of the solubility of FK-4 ferrocenyldimethyl carbinol (versus that of ferrocene) in solvents used in gasolines and motor fuels. The following solvents were

used in tests to compare the solubility of FK-4 and ferrocene: paraffin hydrocarbons (hexane, heptane, octane, and petroleum ether); aromatic hydrocarbons (benzene, toluene, and n- and o-xylenes); the naphthene hydrocarbon cyclohexane; and the olefin hydrocarbons hexane and cyclohexene. All solvents were purified by the standard method. FK-4 and commercial-grade ferrocene were recrystallized from hexane. The solubility of ferrocene was studied by direct contact of solid and liquid phases with constant agitation and a constant temperature. The temperatures used during the tests ranged from -15 to +30°C and were maintained with a precision of $\pm 0.1^\circ\text{C}$. In each system studied, equilibrium was achieved after 2.5-3.0 hours and controlled by measuring the optical density of the solutions on an FEK-64 photocolormeter at a wavelength of 390 nm. The experiments established that ferrocene's solubility increases by a factor of approximately 2-3 as the temperature is increased from -15 to +30°C, whereas the solubility of FK-4 increases by only a factor of 1.1-1.2 (except in xylenes and cyclohexane). Both ferrocene and FK-4 are least soluble in paraffin hydrocarbons. The solubility of both is three times greater in octane than in hexane and heptane. The solubility of the study ferrocenes in aromatic hydrocarbons is much higher than that in paraffin hydrocarbons (by a factor of 15-20 in the case of ferrocene and a factor of 40-45 in the case of FK-4). The study ferrocenes were found to dissolve rather well in cyclohexane and unsaturated hydrocarbons (hexane and cyclohexene). The solubility of ferrocene in petroleum ether is on a par with that in hexane or heptane. FK-4, on the other hand, dissolves somewhat better in petroleum ether than in hexane or heptane. In a mixed hexane-benzene solvent, the solubility of FK-4 was found to be additive in nature and be calculatable on the basis of the following equation given benzene concentrations above 5 percent (volume): $S = 0.18N_1 + 1.45N_2$ (where N_1 and N_2 are the respective molar fractions of hexane and benzene in the mixed solvent). The solubility of FK-4 in Au-80 and Au-90 gasolines was only slightly temperature dependent, whereas that of ferrocene was highly temperature dependent: The solubility of FK-4 in Au-80 ranged from 0.142 mol/l (4.74 g/100 g) at -15°C to 0.150 mol/l (5.00 g/100 g) at +25°C, whereas the solubility of ferrocene in Au-80 gasoline ranged from 0.140 mol/l (4.67 g/100 g) at -15°C to 0.273 mol/l (9.11 g/100 g) at +25°C. FK-4 was found to be only one-third to one-half as soluble in water as in the hydrocarbon solvents studied. The process of dissolution of FK-4 in hydrocarbons and gasolines was concluded to be a weakly endothermal process ($\Delta H_{\text{dissolution}} < 4 \text{ kJ/mol}$) except in xylenes and cyclohexane. The process of dissolution of ferrocene was more endothermal ($\Delta H_{\text{dissolution}}$

$\approx 7-10 \text{ kJ/mol}$). The fact that the solubility of FK-4 in gasolines is virtually temperature independent makes it convenient to use in practice. Tables 4; references 4 (Russian).

Analysis of High-Boiling Arylalkylphenols by Capillary Chromatography

957A0327B Moscow NEFTEKHIMIYA in Russian
Vol 34 No 6, Nov-Dec 94 (manuscript received
21 Mar 94) pp 562-567

[Article by T.P. Popova, V.Ye. Shiryayeva, V.G. Berezkin, R.Sh. Abaubakirov, F.Kh. Inoyatov, and V.N. Perchenko, Petrochemical Synthesis Institute imeni A.V. Topchiyev, Russian Academy of Sciences, Moscow; UDC 543.544]

[FBIS Abstract] Quartz capillary columns filled with non-polar and polar liquid phases were used to perform a chromatographic analysis of high-boiling products of the alkylation of mono- and diatomic phenols by styrene. An LKhM-8MD chromatograph was used along with two quartz capillary columns. The first column (25 m x 0.32 mm) contained the nonpolar immobilized stationary liquid phase SE-30 (film thickness, 3.15 μm ; temperature, 50°C; gas coolant, helium; gas coolant flow rate, 40 cm/s; discharge, 80 ml/min; and sensitivity, $100 \times 10^{-12} \text{ A}$). The second column was filled with the polar immobilized stationary liquid phase PEG-20 M (film thickness, 0.17 μm ; temperature, 25°C; gas coolant, helium; gas coolant flow rate, 50 cm/s; discharge, 80 ml/min; and sensitivity, $100 \times 10^{-12} \text{ A}$). Thanks to the use of the high-performance capillary columns with the two immobilized stationary liquid phases, eight high-boiling compounds (with boiling points from 310 to 500°C) were separated: benzyl ether of 2-methoxyphenol, 2-methylbenzylamine, benzyl ether of 4-methoxyphenol, 2- α -methylbenzyl-4-methoxyphenol, 4,6-di(α -methylbenzyl)-3-methoxyphenol, 2,6-di(α -methylbenzyl)phenol, 2,6-di(α -methylbenzyl)-4-methoxyphenol, and 2,4-di(α -methylbenzyl)-3-methoxyphenol. The degree of separation on the nonpolar phase SE-30 ranged from 1.12 to 1.80, whereas that on the polar phase PEG-20M ranged from 3.10 to 4.12. Polar phases were thus concluded to be preferable for analyzing compounds similar to those studied. Short capillary column lengths (less than 10 m) and high gas coolant flow rates (1.8-2.0 times the optimal flow rates) were also demonstrated to be preferred. The retentions on the two stationary liquid phases were calculated and a correlation confirming the accuracy of identification of the analyzed compounds was derived. The chromatographic analysis confirmed that di- α -methylbenzylmethoxyphenols have two chiral atoms and are represented by two diastereoisomers: a racemic pair and a mesoform. Figures 3; table 1; references 7: 5 Russian, 2 Western.

Properties of Track Membranes of Various Thicknesses

957A0281A Moscow KOLLOIDNYY ZHURNAL
in Russian Vol 56, No 6, Nov-Dec 94 (manuscript
received 16 Dec 93) pp 746-750

[Article by P. Yu. Apel, A. Yu. Didyk, N. N. Zhitaryuk, I. Ye. Larionova, T. I. Mamonova, O. L. Orelovich, L. I. Samoylova, and I. V. Yanina, Union of Nuclear Research Institutes, Dubna; UDC66.067.1:62-278]

[FBIS Abstract] For many years track membranes were made from 10 micron thick polymers. This thickness was chosen because fission fragments and accelerated heavy ions with energies less than 1 Mev per nucleon have a relatively short traverse in substances. The heavy fraction of fission fragments "penetrates" a polyethylene-terephthalate layer not over 15 microns thick, while the traverse of xenon ions with the same energy is approximately 17 microns, which set the upper limit in thickness. Theoretically, the coefficient of permeability increases with decreasing membrane thickness. Previous attempts to prepare membranes 5.3 or even 1 micron in thickness resulted in very high filtration rates and very short service life owing to the rapid filling of pores with fissionable particles. Recently, it became possible to use polymer films for irradiation with bundles of heavy ions with energies greater than 1 Mev per nucleon, and polymer films 20-30 microns thick became available as a starting material for preparing track membranes. Thus studying the properties of similar "thick" membranes took on practical significance. In the present work a study was made of the basic characteristics of polyethylene-terephthalate track membranes prepared from 10 and 20 micron thick films. Membranes having 0.2, 0.4 and 1.0 micron pore diameters were tested. Various methods were used to determine density and average pore size, bubble point, and dimensional pore distribution. Resistance to tearing and specific flow rates for water and gas were determined for both membranes. The behavior of the membranes during filtration of tap water was studied and the advantages of using thick film track membranes are discussed. Figures 4; table 1; references 4: 1 Russian, 3 Western.

Rheological Properties of Bilateral Emulsion Films Stabilized with Gelatin-Cetyl Pyridinium Chloride Complex

957A0281B Moscow KOLLOIDNYY ZHURNAL
in Russian Vol 56, No 6, Nov-Dec 94 (manuscript
received 1 Mar 94) pp 751-754

[Article by S. R. Derkach, V. N. Izmaylova, K. V. Zotova, and Yu. V. Pyleyeva, Murmansk State Academy of Fishing Fleet, Moscow State University imeni M. V. Lomonosova; UDC661.185+547.96]

[FBIS Abstract] Some recent work in the new field of colloidal chemistry of biopolymers was directed to studying the effects of low molecular surfactants on

surface properties at the liquid-liquid interface when a high molecular surfactant is dissolved in water and a low molecular surfactant is dissolved in an organic phase. High molecular surfactants at the interface form mechanically sound two-dimensional condensation-crystalline structures as a result of both thickening and phase separation. The structural elements have contact points which are dependent on the properties of the macromolecules due to formation of either hydrogen bonds or by hydrophobic interaction. In another work it has been reported that formation of mixed adsorption layers of gelatin and slightly soluble surfactants (oleic and lauric acids) is accompanied by an increase in strength of the interfacial layer as well as an increase in the lifetime of hydrocarbon droplets to coalescence. Rheological studies were also made of bilateral foam films formed from modified gelatin solutions where it was demonstrated that by modifying the gelatin with low molecular surfactants, it is possible to control the structural-rheological properties of films formed from binary mixtures. In the present work the rheological parameters of bilateral emulsion films, stabilized with gelatin modified with a low molecular surfactant (cetyl pyridinium chloride) were studied for the first time. A comparative analysis of the rheological parameters of foam and emulsion films shows that the decreased rheological parameters of the emulsion films is evidently due to solubilization of the hydrocarbon interfacing in the aqueous phase with complexes formed from gelatin-cetyl pyridine chloride. This results in a compacting of structural elements having a lower number of contact points with the stabilizing adsorption layer, thereby leading to a drop in rigidity of the layer. Figures 3; tables 4; references 7 (Russian).

Electrostatic Reaction of Two Charged Gel-Layers

957A0281C Moscow KOLLOIDNYY ZHURNAL
in Russian Vol 56, No 6, Nov-Dec 94 (manuscript
received 25 Mar 94) pp 767-773

[Article by N. I. Zharkikh and S. S. Dukhin, Biocolloidal Chemistry Institute, Kiev, Colloidal Chemistry and Chemistry of Water Institute, Kiev; UDC537.363:537.311.3:54-148]

[FBIS Abstract] The generally accepted theory on the stability of hydrogels developed by Deryagin, Landau, Vervy, and Overbeek (DLFO) is closely related to the classical model of the electric double layer (DES). According to this model, the surfaces of particles have a charge concentrated in an infinitely thin layer, and that this charge is compensated by a another charge located in a diffusion lining. The chief parameter characterizing the DES in this model is the surface potential (ζ -potential), and that if all precepts are met, the ζ -potential may be calculated from electrokinetic data and then used in formulas of the DLFO theory. Research has shown that the classical DES model satisfactorily explains experimental data for many real colloidal objects, especially silver iodide. However, analogous research conducted on

other objects, especially oxides, showed a glaring incapability of this classical model to correlate various measured values, such as the great difference between the very large value of fixed charges of particles and surface conductivity on the one hand, and the low value of electrophoretic mobility and stability on the other. To avoid these difficulties, various corrections to the classical model have been proposed, including one by J. Lyklema who advanced the hypothesis that the particles are covered by a gel-layer in which is concentrated a significant part of the mobile DES charge, and that only a small part of the full DES charge (the so-called electrokinetic charge) is located in the traditional diffusion layer, i.e., in free solution beyond the limits of the gel-layer. While this hypothesis was advanced by others, the work was concerned mainly with behavior of the surface charge and questions concerning stability within the framework of the DES model were left open. In the present work a general approach is made to building a theory of ionic-electrostatic interaction between particles and charged gel-layers, and some simple limiting cases of general formulas are analyzed. Figures 4; references 8: 3 Russian, 5 Western.

Activation Mechanism for Forming Viscosity in Magnetic Colloids

957A0281D Moscow KOLLOIDNYY ZHURNAL in Russian Vol 56, No 6, Nov-Dec 94 (manuscript received 16 Dec 93) pp 774-777

[Article by A. Yu. Zubarev, Urals State University, Yekaterinburg; UDC541.18:538]

[FBIS Abstract] Several mechanisms exist for the formation of effective viscosity in magnetic colloids. The first, analogous to Einstein's classical theory of effective viscosity in suspensions, presupposes that a particle suspended in a liquid disrupts its flow leading to a growth in the dissipation of energy of flow, and therefore the viscosity of the suspension. The magnitude of the disruption, and the viscosity are predetermined by the magnitude and orientation of the magnetic field. This mechanism was examined in other works where it was assumed that the particle concentration was low and that particle interaction could be neglected. With intensification of particle interaction, the particles become capable of forming aggregates and chains which are subject to disruptive forces. It is also probable that in very dilute ferro-colloids viscosity formation by a mechanism analogous to a newer mechanism which presupposes that the particles overcome the barrier potentials arising during interaction with other particles. In the present work a theoretical study was made and a model of this new mechanism of viscosity formation in magnetic colloids is presented. References 13: 11 Russian, 2 Western.

Electrochemical Characteristics of Membranes of Macroporous Glass in HCl and KCl Solutions

957A0281E Moscow KOLLOIDNYY ZHURNAL in Russian Vol 56, No 6, Nov-Dec 94 (manuscript received 20 Dec 93) pp 782-787

[Article by L. E. Yermakova and M. P. Sidorova, St. Petersburg State University; UDC666.112.6:62-278:541.13]

[FBIS Abstract] Porous glass membranes whose pore radii are equal to or greater than 10 nm are called macroporous glasses. Their preparation includes a secondary alkali leaching stage which results in practically total elimination of secondary silica from the pore spaces and an increase in pore size. In the present work macroporous membranes with pore radii of 11 and 64 nm were prepared from sodium borosilicate glass and their electrochemical characteristics studied over a wide range of HCl and KCl concentrations. It was demonstrated that the counter-ion transfer number and coefficient of efficiency, both being indicative of the input of ions of the electric double layer during membrane transport, diminish with growing electrolyte concentration and pore radius. The resulting structural membrane parameters, electrical conductivity, and flow potential data were utilized to calculate electrokinetic potential, concentration of mobile charge, and ionic concentration in the pore solution, as well as the convection component of electrical conductivity and counter-ion mobility in membranes. Figures 2; tables 9; references 8: 5 Russian, 3 Western.

Kinetics of Phase Separation in Binary Mixtures. Consideration of Results

957A0281F Moscow KOLLOIDNYY ZHURNAL in Russian Vol 56, No 6, Nov-Dec 94 (manuscript received 1 Aug 93) pp 805-807

[Article by O. M. Lapteva, G. I. Pozharskaya, Yu. D. Kolpakov, S. P. Samokhin, and V. P. Skripov, Thermal Physics Institute, Yekaterinburg; UDC536.42:532.77-2]

[FBIS Abstract] In a previous work a microphotographic study was made of the growth kinetics of a new phase in the following binary stratifying solutions: perfluoromethylhexane-carbon tetrachloride, perfluorohexane-hexane, nitrobenzene-hexane, aniline-cyclohexane, and lutidine-water. According to the modern approach, there are two stages in the growth process. In the first diffusion stage, the droplets of the new phase form and grow by diffusion and coalescence and the relationship of radius R to time t follows the law $R(t) \approx t^{1/3}$. As the radius increases, the droplets coagulate due to surface tension and gravitation forces and enter a second stage and follow the linear law $R(t) \approx t$. In the present work a microphotographic study was made of relationship of the growth law to the volume fraction of the formed phase in the above solutions. It was demonstrated that in the later stage the radius of the new phase droplets varies time in a step-wise law with a unit index = 0.81. Figures 4; table 1; references 9: 3 Russian, 6 Western.

Effect of Disaccharides on Resistance of Vesicles from Phosphatidyl Choline to Low Temperatures According to NMR Data

957A0281G Moscow KOLLOIDNYY ZHURNAL in Russian Vol 56, No 6, Nov-Dec 94 (manuscript received 14 Mar 94) pp 833-839

[Article by V. V. Rodin and V. N. Izmaylova, Moscow State University imeni M. V. Lomonosov; UDC 541.183.02+539.143.43]

[FBIS Abstract] The stability of lyophilic colloidal systems cannot be comprehended on a modern level without physical chemical study of molecular mechanisms of interaction of the dispersed phase with the dispersion medium and their dynamic structures under various conditions. Many features of such systems may be clarified on the basis of highly diphilic surfactant molecules, especially phospholipids. Poorly soluble in water, phospholipid dispersed systems are normally prepared by ultrasonification of aqueous dispersions to form vesicles. Aqueous dispersions of phospholipid vesicles are classical lyophilic colloidal systems. In many cases the vesicles behave as model biological and medical objects and are used to study hydration of membranes and their damage during extreme conditions. In the present work NMR was used to study the effects of disaccharides on the resistance of lyophilic colloidal system—vesicles of phosphatidylcholine (FKh) to low temperatures. Two programs of vesicle treatment were used: freezing (to -30°C)—re-warming at room temperature, and freezing (-196°C)—drying-rehydrating. It was observed that the NMR-spectra of the FKh-vesicles, after being subjected to the first or second program disappear almost entirely, attesting to the destruction and loss of the bilayer. The presence of disaccharides in the vesicle dispersions during treatment prevents disappearance of NMR signals. Optimum disaccharide concentrations were calculated for the formation of a protective layer around the vesicles. It is hypothesized that the protective properties of the disaccharides results from the membrane surfaces interacting with the structure of water. Carbohydrate molecules displace water molecules in the vicinity of polar groups of the phospholipids, thereby screening the vesicle membrane from the mechanical pressure of growing ice crystals. Figures 4; references 27: 14 Russian, 13 Western.

Oxygen Conductivity and Chemical Diffusion in $\text{PrBa}_2\text{Cu}_3\text{O}_{6+x}$

957A0378A Moscow ELEKTROKHIMIYA in Russian Vol 30 No 12, Dec 94 (manuscript received 10 May 94) pp 1470-1475

[Article by M.V. Patrakeyev, I.A. Leonidov, V.L. Kozhevnikov, and A.K. Demin, Solid-State Chemistry Institute, Ural Department, Russian Academy of Sciences, Yekaterinburg; UDC 539.219.3:546.656'431'56-31]

[FBIS Abstract] The ionic oxygen conductivity of the cuprate $\text{PrBa}_2\text{Cu}_3\text{O}_{6+x}$ was studied at temperatures ranging from 600 to 850°C and oxygen pressures of 8.1 to

101.3 kPa. The $\text{PrBa}_2\text{Cu}_3\text{O}_{6+x}$ was synthesized from the oxides Pr_6O_{11} and CuO and barium carbonate (BaCO_3) with a starting purity of at least 99.99 percent (weight). Ionic oxygen conductivity was measured by determining the stationary flow of oxygen ions through a gastight ceramic membrane with a low oxygen pressure difference in the gaseous phase from the different sides of the specimen. From 2 to 20 hours was required for establishment of a stationary state in the cell depending on the partial oxygen pressure, temperature, thickness of the membrane, and increment of temperature change. The coefficient of chemical diffusion of the oxygen was calculated along with the activation energy (U) of oxygen conductivity given constant levels of oxygen in the specimen in the range $0.35 < x < 0.60$. Analysis of the temperature dependences of oxygen conductivity at different oxygen pressures indicated that increasing the partial pressure in the gas phase results in a significant increase in oxygen conductivity. When the partial oxygen pressure is kept constant, the temperature change within the temperature range studied has only a weak effect on ionic conductivity. On the basis of previously obtained data regarding oxygen stoichiometry in $\text{PrBa}_2\text{Cu}_3\text{O}_{6+x}$, it was established that increasing x results in a sharper increase in oxygen conductivity at low temperatures than at high temperatures. For the tetragonal phase, U was found to range from 2.46 to $1.57x$ (eV). Calculation of the coefficient of chemical diffusion of oxygen in accordance with the Nernst-Einstein relationship established that the said coefficient is higher in the case of $\text{YBa}_2\text{Cu}_3\text{O}_{6+x}$ than in the case of $\text{PrBa}_2\text{Cu}_3\text{O}_{6+x}$ on account of the higher activation energies in yttrium-barium cuprate. Thus both oxygen conductivity and the coefficient of chemical diffusion in $\text{PrBa}_2\text{Cu}_3\text{O}_{6+x}$ were significantly dependent on the oxygen content. Figures 6; references 7: 1 Russian, 6 Western.

Aminostigmine Development Described

957A0460A Moscow KHIMIYA I ZHIZN in Russian No 12, Dec 94 pp 29-31

[Article by V.B. Prozorovskiy, doctor of medical sciences, and L.V. Pavlova, candidate of chemical sciences under the "Diseases and Drugs" rubric: "Bean-Based Drug"]

[FBIS Translated Text] Being under the autumn wind in the Irish Sea was no joke. The waves smashed against the wharf and made the graceful brigantines and even the enormous iron steamships dance. The longshoremen unloading the hulls filled with goods from overseas strained themselves to the utmost.

Then a large chest appeared over the side of one of the vessels and sailed in the air, rocking on the lifting tackle. It was destined for the warehouse, but a different fate befell it: the wind roared, smashed the chest against the beam holding the blocks, and scattered the appetizing-looking beans it contained over nearly the entire port.

The port children flocked to gather the booty, stuffing it in their pockets, in their shirts, and sometimes directly in their mouths. They were unable to gather up all of the peas. The wind swept some into the sea and mixed some in with the trash.

But soon Liverpool's port region resounded with lamentations: The children brought the poison home and those who ate even one pea or just a few on the way home were themselves poisoned. With their faces turning blue, gasping for breath from choking and from the foam frothing in their throats, and with their bodies shaking all over, they lay in their beds or simply on the street, begging for help. And help arrived almost immediately.

The chest's owner knew that it contained Calabar beans—the fruit of the poisonous plant *Physostigma*, which was harvested on the Calabar shore on the coast of the Gulf of Guinea at the request of Cambridge University. Scientists first became acquainted with the beans while examining the collection of African plants brought back by Scottish naturalist R. Christensen in 1855. Back in 1864 Professor L. Klayevakhter [transliteration] detailed poisoning by an extract of African beans and discovered that the antidote was an extract of another poisonous plant that is not so exotic, namely, deadly nightshade or belladonna.

And what happened to the children? Because the alarm was sounded in time, all were able to be taken to the hospital. To the credit of the local physicians, they knew about the antagonism between the poisons of these plants, and they were able to save nearly all of the children's lives. Only one child who was brought to the hospital late died. It seems strange that the annals of history have preserved the ordinary case of the death of one little boy during times when plague, smallpox, and cholera took thousands of lives in port cities each year. It is possible that Klayevakhter's toxicology studies remained in the Liverpool physicians' memories because it was one of the remarkable triumphs of medicine of that time: At the beginning of one year a scientist issued theoretical recommendations regarding treating cases of poisoning by a little-known poisonous plant, and at the end of the same year physicians used his recommendations to save 70 young lives.

But history was not finished with Calabar beans. Like all poisonous plants, they also possessed therapeutic properties. By the end of the 19th century, their extract was already being widely used in medical practice. Russian physicians M. Petrzhevskiy and V. Dybkovskiy were among the first to discover its medicinal effects. They discovered the new drug's ability to heal glaucoma and eliminate life-threatening decreases in intestinal tonus after operations. In the same years, J. Jabet and O. Hesse independently isolated the active ingredient of Calabar beans. One called it *physostigmine* after the name of the plant's genus, while the other called it *eserine* after *esere*, the African word for the beans.

At the beginning of the 20th century, it was established that nerves transmit stimuli to actuator organs by means

of an intermediary chemical called a mediator: Figuratively speaking, they issue an order to their subordinates in chemical language. Later, in the 1930s, it became clear that one of the main mediators in the central and peripheral nervous systems was an ester of the alcohol choline and acetic acid, i.e., acetylcholine. Its effect has been described in rather great detail in textbooks and is certainly not worth repeating. We will only mention that after it enters the synaptic fissure and reacts with protein molecules on the surface of the actuator organs' membranes and after it has performed its function, acetylcholine is broken down by the enzyme acetylcholinesterase into choline and acetic acid. The choline returns to the nerve ending where it is needed to synthesize a new batch of acetylcholine, and the acetic acid becomes part of the metabolic cycle—the body has enough without it.

In 1930 it thus became clear that eserine inhibits hydrolysis of acetylcholine by the enzyme acetylcholinesterase. In other words, the mediator continues issuing orders, and the actuator continues working. When the latter hears an order that is not whispered but that is instead shouted, it is, as they say, ready to lay itself out. However...

However, eserine (or physostigmine if you prefer) is a very unstable substance and degrades not only at elevated temperatures but also under direct light. Drugs made from it cannot be sterilized and are very difficult to store.

And then the structure of acetylcholine and eserine molecules were taken and compared (Figure 1). Later, those parts of the molecules indicated in Figure 1 by bold lines were extracted and a new drug that became known as neostigmine was synthesized. In the USSR, this substance became known as *prozerin*, which stood for eserine substitute (cf. rector and prorector). As expected, prozerin proved to be a good cholinesterase inhibitor and to this day is widely used in medical practice.

Unfortunately, prozerin has one drawback—it can only be used to control the autonomic nervous system. The positive charge of prozerin's molecule does not allow it to penetrate through the so-called blood-brain barrier that separates the blood from the brain cells. On the other hand, that is a good thing. Why, for example, alarm the brain if a drug needs to act upon the intestine. On the other hand, it is bad.

We will recall the physostigmine agonist belladonna and other poisonous plants—henbane and datura. They often cause severe cases of poisoning. The cases are severe because their active ingredients—atropine and scopolamine—easily penetrate the blood-brain barrier and cause acute psychoses (remember the line. "What's wrong with you, have you eaten henbane?") and even death. It was the juice of henbane that poisoned Hamlet's father. And not just him.

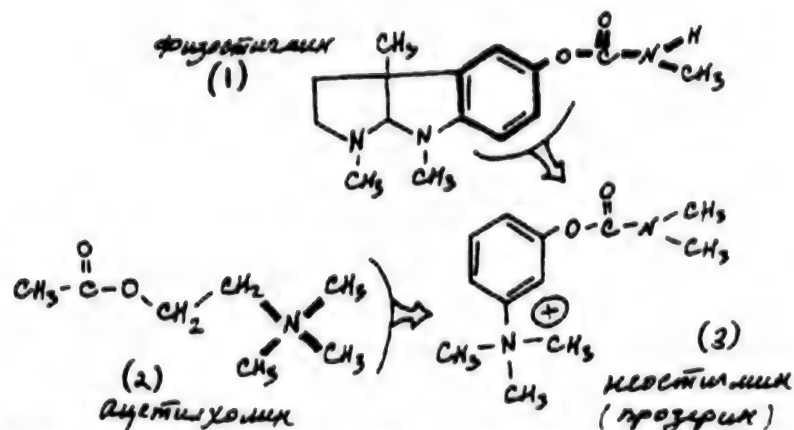


Figure 1. Here is how the drug neostigmine was produced from acetylcholine and an extract of Calabar beans (physostigmine).

Key: 1. physostigmine; 2. acetylcholine; and 3. neostigmine (prozerin).

Furthermore, a group of drugs has now appeared that act exactly as atropine (for example, benactyzine) or nearly like atropine (tsiklozil [transliteration]) or by and large like atropine (dimedrol, pipolphen, and imipramine). We will not go into details, but from time to time, people are poisoned by one or another of these substances. And until recently, they had no good and readily available antagonist. In the search for a prozerin substitute capable of penetrating the blood-brain barrier, 73 derivatives of physostigmine and prozerin were tested before discovering a substance possessing the required properties (Figure 2). We called it aminostigmine. An inexpensive commercial synthesis method developed by R.G. Glushkov, academician of the Russian Academy of Medical Sciences, makes it possible to produce the drug in large quantities at a very low cost. It is now being widely

used in clinical practice and as an antidote in cases of poisoning by many substances that are to one degree or another similar to atropine.

It is difficult to forget the scene witnessed by one of the authors of this article. A young girl who had ingested several dimedrol tablets was brought to the clinic of the Leningrad First Aid Institute. She was confused, her movements were disoriented, she was drowsy, and judging by some of her cries, she was suffering from hallucinations. After drawing just 1 ml of aminostigmine into a syringe, the physician treating her slowly injected it into her intravenously. He barely had time to extract the needle before the girl rose up from her pillow, looked at everyone present meaningfully, and asked, "Where am I? What happened to me?" After one day of observation (without any additional treatment), the patient was sent home. It was like a miracle.

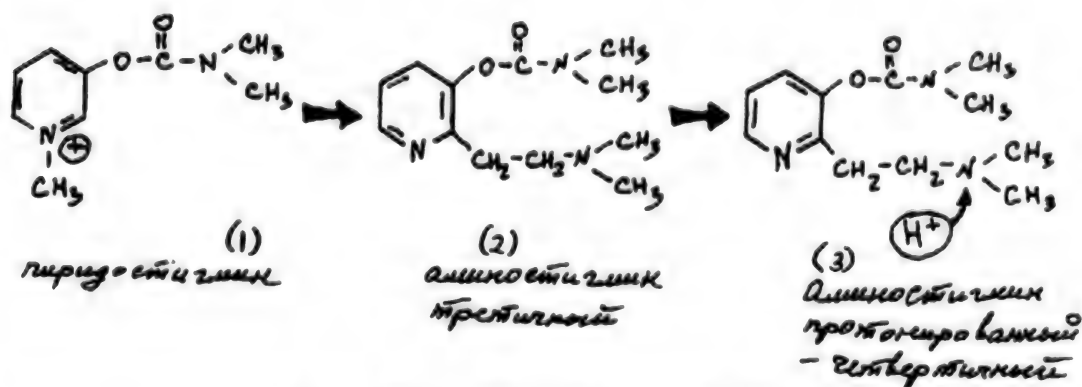


Figure 2. Diagram of the synthesis of aminostigmine.

Key: 1. pyridostigmine; 2. tertiary aminostigmine; 3. protonated quaternary aminostigmine.

Aminostigmine successfully stimulates sexual activity, which means that it may help in cases of neurogenic impotence. It also eliminates short-term memory disorders—what is called anterograde or senile memory, where a person clearly remembers events from his distant childhood but does not remember where he put his eyeglasses while they are sitting on his nose.

And finally, aminostigmine possesses an almost unique rodenticidic effect. It is more toxic to rodents, mice and

rats, than to cats, dogs, or humans. Its effect is virtually instantaneous. The mouse does not even have time to run to his den in the corner of the room. People who share their living space with rodents and have used other rodenticides without success, have nothing but praise for aminostigmine. But here is the paradox: the drug is officially approved for people but banned from use in destroying mice and rats. Perhaps this article will help change that policy?

Ecologically Hazardous Concentrations of Contaminating Elements in Coals

957A0370A Moscow OTECHESTVENNAYA GEOLOGIYA in Russian No 9, Sep 94 (manuscript received 23 Apr 94) pp 63-68

[Article by L. Ya. Kizilshteyn, Scientific Research Institute for Physical and Organic Chemistry; UDC 504.3.054.001.18+502.7]

[FBIS Translated Text] A considerable part of the contaminating elements (CE) present in coals during combustion enters into the atmosphere as aerosols and gaseous products in smoke plumes. In one form or another they are capable of exerting unfavorable influences on living organisms in the biosphere, including man.

Although CE in the sense of this term constitute only an insignificant part of the mass of organic matter, among them, in turn, there are very great differences in concentration (from a few to 10^{-4} percent, that is, of not less than 4 orders of magnitude. Representing all the groups of the periodic system, these elements are exceedingly diverse in their chemical properties.

Ecologically dangerous CE in coals. Available data [4, 17] indicate that the percentage of energy in the anthropogenic emission of CE into the atmosphere is extremely significant, for example (in percent of the total entry): Co—98, Cr—15, Cu—32, Ni—77, Sb—80, Se—50, V—85, Zn—10, Cd—9, As—6, Hg—20.

During recent years exceedingly dangerous carcinogenic substances containing CE, including such as are unquestionably present in the smoke plumes of thermal electric power plants (TEPP): cadmium sulfates, compounds of chromium and nickel. Many other CE also are pollutants: Li, Be, B, F, Cl, V, Cr, Mn, Co, Ni, Cu, As, Se, Zn, Cd, Sb, Hg, Tl, Pb, Bi [3].

The impact of CE and their compounds may be intensified with their joint influence on biospheric elements (synergism). Beryllium and fluorides are cited as an example of the synergic effect. The presence of fluorides accelerates the pathologic processes in the lungs initiated by beryllium [3]. Sulfur and solid dust particles, the traditional components of atmospheric pollution, possess demonstrated synergism. Modern large thermal electric power plants, operating virtually continuously over the decades, even with low (near-background) concentrations of toxic elements in coals, are becoming the source of a negative impact on the biosphere not only in adjacent, but even in remote areas. It is known, for example, that with the discharge of mercury compounds from high stacks their concentration in the atmospheric surface layer as a result of dispersion usually does not exceed the admissible norms. However, as a result of gradual accumulation in the soil layer and chemical transformations the toxicity and potential danger of this element systematically increase even at great distances from the source. It also has been

established that prolonged exposure to small concentrations of pollutants is more dangerous than brief exposures to high concentrations [3].

In accordance with the prevailing norm-setting documents [2], the results of geologic prospecting work should yield data on the distribution of toxic CE in coal strata necessary for planning environmental protection measures during production, processing and use of coals. Provision is made for detecting in coal strata those zones containing CE exceeding the level of so-called hypothetically hazardous concentrations. In addition, CE must be evaluated as "valuable," being a special resource in combined use of the wastes of mining, concentration and processing of coals.

The evaluation of CE as "valuable" and "toxic" is a problem of different levels of complexity. Whereas "value," that is, suitability at the present time or in the foreseeable future for industrial use, in principle can be determined on the basis of technical-economic computations, the "toxicity" evaluation requires that allowance be made for a number of factors poorly studied or completely unknown.

The degree of the unfavorable impact of CE, whose toxicity has been established by sanitary-hygienic observations, is dependent on their concentration in coals, the chemical form of bonding with other components of coal matter, the nature of the compounds forming in the high-temperature fuel combustion medium, the forms of entry into the environment, the degree of accumulation in soils and living organisms, movement through trophic chains, etc.

We will draw attention to the first two components in the cited list. Both of these apply to that branch of coal geology which has been assigned the name "Geochemistry of Contaminating Elements in Coals." An extensive literature has been devoted to the corresponding problems. In the environmental protection aspect of the results we will point up the following: the concentrations of CE in coals vary in different basins and deposits and in addition, vary in an area of occurrence of coal strata; in coals of different basins and deposits the CE are distributed differently among the organic and mineral components of coal matter.

The second point is particularly important because the distribution of CE among components governs whether they will remain in the ash and slag during the combustion of coals or will be emitted into the atmosphere in the gaseous and aerosol phases of the combustion products. It was noted earlier in [10] that the CE present in the organic components of coals and also in the sulfides and carbonates decomposing at high temperatures to a considerable degree (possibly completely) pass into gaseous and aerosol phases (henceforth in the text, for the sake of brevity, simply designated as "gaseous"), whereas those present as part of clayey minerals for the most part remain in the ash and slag. It is entirely evident that

precisely that part of the CE which is in a gaseous phase has a negative impact on atmospheric air with the ecologic consequences following from this.

Taking into account what has been said, a fundamentally important conclusion can be drawn: hazardous CE concentrations must be determined for each basin and deposit individually.

Since a negative ecologic impact arises as a result of formation of discharge of a CE in the gaseous phase, it is understandable that dangerous concentrations must be directly dependent on what part of the CE passes into the latter during the combustion of coals. In addition to the geochemical characteristics of the distribution of CE in coals, which were examined in [12, 13], the entry of CE into the gaseous phase is influenced to a considerable degree by the conditions under which coals are burned (especially temperature) and the efficiency of systems for the cleanup of smoke gases (ash collection). It must be noted that most CE are in the gaseous phase of smoke effluent not in a truly gaseous state, but in solid particles (in ash). This is attributable to the fact that the temperature of the gaseous state of the CE is considerably greater than the temperatures of the gas channel in the TEPP, as a result of which even before discharge into the atmosphere the CE are in a silicate melt of mineral matter or in a condensation film on the surface of solid particles. These matters were examined in detail in [9]. Only a few CE, probably F, Cl, Br, I, Re and Hg, enter the atmosphere in the form of gaseous compounds.

At modern large thermal electric power plants the combustion products are cleaned up most frequently by a system of electric filters, which in a normal operating mode are capable of ensuring precipitation of 99-99.5 percent of the solid particles (ash removal). The efficiency of ash removal is determined by the physicochemical properties of the ash and gases, in particular, by the density of the solid particles, their dispersed composition and resistivity. The solid particles passing through ash-removal systems ("stages") on the average are considerably finer than the ash as a whole. It has been established by special observations that the concentration of CE in ash particles increases with a decrease in their size. For lead, for example, the following data are given (coarseness class of ash particles, μm —lead content, g/ton): 40—90; 30-40—330; 20-30—430; 15-20—520; 10-15—630; 5-10—820; 5—980 [20].

It is clear from what has been said that it is scarcely possible to determine the real entry of CE into the gaseous phase solely on the basis of geochemical information. This difficulty can be overcome by one of two methods.

The first is used in a case when hazardous concentrations are determined for the coals of basins, deposits or coal industry regions exploited by the coal industry and delivering fuel to known thermal electric power plants. Assuming that within the bounds of a single facies type

of coal accumulation the distribution of CE between the components of coal matter in general should be of the same type, it is possible to estimate the gaseous phase on the basis of balance computations applicable to a specific type of coal-burning thermal electric power plant. This requires the following initial information: mass of CE in coal burned in a unit time CE_c ; mass of CE in the removed ash forming during the combustion of this coal CE_a and in the slag CE_s . The entry of the CE into the gaseous phase CE_{gph} (in percent) is determined using the formula:

$$CE_{gph} = CE_c - (CE_a + CE_s)/CE_c \cdot 100.$$

Taking into account the possibility of variance of the indicated indices, it is necessary to operate with their statistical evaluations, relying on repeated sampling during the technological process of preparation of the fuel and in the combustion products. We note that the entry of CE into the gaseous phase (in percent or fractions of unity) is not dependent on their concentrations in coal, but only on the geochemical characteristics of the CE in coals: primarily on the distribution among organic and mineral carriers and the behavior of the latter in high-temperature combustion processes. For this reason the enormous amount of information on the geochemistry and geology of CE in coals accumulated over the course of many years is acquiring new, extremely timely significance.

The second method for estimating the gaseous phase must be used when dangerous CE concentrations are determined in coals not exploited by the mining industry and in regional power production. In this case it is possible to use laboratory stand apparatus entirely adequately simulating the conditions for the distribution of CE among the combustion products in industrial boiler plants. Their merit relative to the characteristics found from geological prospecting work is that the implementation of tests requires relatively small masses of material—tens of kilograms. Experience with use of such apparatus not only for solution of the considered problems, but also for evaluating the possible directions in utilization of the ash-slag combustion wastes on the basis of materials from geological prospecting studies, is set forth in [11, 15].

Information on the entry of CE into the gaseous phase obtained by one method or another is crucial for determining hazardous CE concentrations in coals.

Determination of hazardous CE concentrations in coals. The atmospheric propagation of smoke plumes from TEPP occurs as a result of the movement of air masses which complexly interact with one another and with the Earth's surface. As a result of wind flows and the vertical air ascent due to the vertical temperature gradient a directed movement of the pollutant arises, complicated by the presence of unordered eddies causing a turbulent movement of masses. Proceeding on the assumption of movement of the pollutant in conformity to turbulent

diffusion laws, at the Main Geophysical Observatory of the RF Main Administration for Hydrometeorology and Environmental Monitoring, under the direction of M. Ye. Berlyand, a mathematical model of atmospheric dispersion of gaseous and aerosol impurities was constructed [1, 2] which served as a basis for a national norm-setting document—OND-86 [16]. Adherence to this document is obligatory when computing the concentrations of hazardous substances and also when normalizing their discharge into the atmosphere during the construction, reconstruction and designing of enterprises.

The maximum surface concentration of a hazardous substance c_m (in mg/m^3 during the discharge of a gas-air mixture from a single point source with a circular orifice (in the case of presence of several closely spaced sources they can be combined into one with an equivalent intensity of the discharge or a special computation method can be used) is attained under unfavorable meteorological conditions at a distance x_M from the source and is determined using the formula [16]:

$$c_m = \frac{AMFm\eta}{H^2\sqrt{V_1\Delta T}}, \quad (2)$$

where A is a coefficient dependent on atmospheric stratification temperature; F is a coefficient taking into account the rate of precipitation of hazardous substances in the atmosphere; m , n are coefficients taking into account the conditions for discharge of the gas-air mixture from the orifice of the effluent source; H is the height of the effluent source above the surface; m ; V_1 is the discharge of the gas-air mixture, m^3/s ; η is a coefficient taking the influence of local relief into account; ΔT is the temperature difference between the discharged gas-air mixture and the temperature of the ambient atmosphere, $^\circ\text{C}$.

The values of the coefficients in equation (2), the computation methods, necessary explanations and examples are given in [16]. That source also gives the methods for determining pollutant concentrations in the surface air layer at different distances from the source under different meteorological conditions, including the position of the point x_M with the maximum concentration.

Equation (2) makes it possible to estimate the mass of the hazardous substance discharged into the atmosphere under the condition that this mass must not give rise to concentrations exceeding the MAC_{CC} (maximum admissible concentration) in the surface air layer. Since the effluent mass is dependent on the concentration of the pollutants (CE) in the burned coal, the possibility is afforded for estimating the upper limit of the CE concentration in coals which when exceeded gives rise to an ecologically dangerous air pollution.

In order to determine dangerous concentrations equation (2) must be solved for M under the condition that c_m is the MAC_{CC} for a given CE. By knowing the entry of

the element into the gaseous phase and the mass of coal burned in a unit time it is possible to ascertain the critical concentration of CE in coals whose exceeding will result in exceeding of the MAC. It is easy to see that these also are "dangerous" concentrations.

In accordance with equation (2) the scales of discharge of pollutants are dependent on the technology for the combustion of coals (technological parameters of the TEPP): height of stacks, their number, rate of gas escape from stack orifices, gas temperatures. All these factors were examined in [16]. With respect to this article it is important to note that the danger of CE must be estimated relative to specific electric (thermal) sources or some standard (operative or planned in this region) source or those which have the poorest, from the ecologic point of view, technical parameters.

The application of the described method is illustrated in the example of the coals of the Eastern Donbass and the Novochoerkassk GRES (State Regional Electric Power Plant) with a capacity 2400 MW, being the principal power source for the RF Rostov Oblast. The uniformity of the paleogeographic and geochemical conditions for coal (peat) accumulation makes it possible to extend the resulting estimates of dangerous CE concentrations to the Donbass Basin as a whole, especially since the majority of the large TEPP burning Donbass coals have combustion systems and systems for the cleanup of smoke effluent similar to those used at the Novochoerkassk GRES.

Dangerous CE concentrations in coals of the Eastern Donbass. Dangerous concentrations of four elements in coals for which on the basis of preliminary data it was possible to assume an excess of the mean concentrations above the dangerous levels were estimated. These elements were beryllium, manganese, selenium and thorium. The inclusion of thorium in this list is motivated by the fact that its natural isotope ^{232}Th may give rise to a multiple exceeding of the admissible atmospheric concentrations in the neighborhood of a coal-burning TEPP if it is evaluated relative to radiation norms.

An estimate of the dangerous concentrations was made on the basis of information on the entry of CE into the gaseous phase, MAC_{CC} [5, 6] and the admissible atmospheric concentrations of radio nuclides for entities of category B (AC_B) [19]. The gaseous phase, in turn, is determined by balance computations (1) applicable to the technology for the burning of coals at the Novochoerkassk GRES, the parameters necessary for whose computation were given in [14].

The choice of the association of studied elements was dictated, in addition, by their geochemical characteristics. They constitute the principal groups of elements with respect to their migrational characteristics in the Earth's crust [18]: Be, Th—lithophilic cation- and anionogenic with a constant valence, Se—chalcophilic, Mn—siderophilic. In accordance with their geochemical and migrational properties these CE are bound in coals with

different carriers: Be, Th - - predominantly with clayey matter, Se, Mn—with clayey matter and sulfides. This, as indicated above, exerts an influence on entry of CE into the gaseous phase during combustion.

The mean concentrations of CE were estimated on the basis of determinations by the neutron activation (Mn, Se, Th) and emission spectrum (Be) methods. The number of determinations was: Be—about 600; Mn, Sc, Th—about 2300 each. The mean concentrations of CE were computed in the coals of the Eastern Donbass by "weighting" to the reserves of coals of industrial categories (A + B + C₁) in the fields of operating mines, reserve and geological prospecting sectors. The mean CE concentrations obtained in this way are (in g/ton): Be—2.5; Mn—88.9; Sc—6.8; Th—11.7.

A comparison with global estimates (for bituminous coals) [21] indicates that in the coals of the Eastern Donbass the concentrations of manganese, selenium and thorium are considerably higher than, whereas those of beryllium are approximately equal to the mean estimates. This gives evidence of an increased ecologic danger of basin coals used in power generation.

The computed values of dangerous concentrations of the studied CE (see table) are considerably lower than those cited in the current norm- setting documents [8]. It is sufficient to compare (first figure—author's data, second figure—from [8], g/ton: Be 08 - 50; Se 1.9 - 50; Mn 37.3 - 1000; Th 373.7—no data. Thus, the degree of danger of the studied CE, at least applicable to the Eastern Donbass, is greatly understated.

Among the studied CE Th merits special attention. The hazardous concentrations of this element in coals are considerably above the means, which conveys the impression that its ecologic estimates are invalid. A similar conclusion follows from the MAC of Th as a chemical toxicant [14]. However, it is known that the isotope ²³²Th is among the widely occurring natural radio nuclides and as such must be evaluated with allowance for its radiation impact [19]. Specially made studies indicated that the dangerous activities of ²³²Th in coals are 0.14 Bq/kg, which corresponds to a concentration of elements in coal of 0.03 g/ton. Thus, as a radiation impact factor the mean Th concentrations in coals considerably exceed the admissible levels.

Ecologically dangerous concentrations of contaminating elements in coals of Eastern Donbass applicable to combustion conditions at Novocherkassk State Regional Electric Power Plant

Element	Mean concentration in coal, g/ton	Coefficient of entry into gaseous phase	MACCC, 10 ⁻⁴ mg/m ³	Dangerous concentration, g/ton
Be	2.5	0.64	0.1	0.8
Mn	88.9	0.78	6	37.3
Sc	6.8	1.0	0.4	1.9
Th	11.7	0.39	30	373.3

Note. The maximum concentration of the CE with a dangerous wind speed of 5.6 m/s is attained at a distance 5.5 km from the GRES.

The author takes this opportunity to draw attention to the need for a more thorough study of the patterns of distribution and concentration of thorium in basin coals.

Environmental protection measures in regions where thermal electric power plants are under construction or are being reconstructed may be more effective if information on the possible level of atmospheric pollution by the toxic products of fuel combustion are made available to planning and design organizations together with other materials from geological prospecting work characterizing fuel quality. The predictive estimates of atmospheric pollution accompanying fuel combustion possible in this case make it possible when planning and designing new and reconstructing operating thermal electric power plants to make optimum technical and economic decisions for the purpose of maintaining ecologic equilibrium in adjacent territories. Experience with modern thermal electric power production indicates that such decisions can be realized in the choice of: optimum mixtures of fuel of different composition; fuel combustion mode; effective systems for trapping toxic components; optimum height of stacks; most favorable sites for positioning thermal electric power plants. In addition, an

improvement in the ecologic situation in regions of large-scale fuel combustion can be attained by the mastery of new combustion technologies. In particular, as indicated by experience in industrially well-developed countries, a decrease in hazardous effluent from thermal electric power plants is achievable by the combustion of coals in a boiling layer with carbonate additives (boilers with a circulating boiling layer—CBL). The CBL technology makes possible a substantial decrease in the discharge of nitrogen and sulfur oxides, as a result of which this combustion system is regarded as the most promising system for high-output power units of coal-burning thermal electric power plants of the future. The author and his colleagues, on the basis of stand tests, established that the CBL technology also is effective with respect to many CE [11]. For example, entry of the CE investigated in this article was (in fractions of unity): for Be—0.47, Se—0.63, Mn—0.34, Th—0.33, which is considerably lower than the corresponding indices for thermal electric power stations with a coal dust combustion system (see table).

If all the parameters entering into formula (2) are taken the same as for the Novocherkassk GRES, the dangerous concentrations of the enumerated CE will be equal (in

g/ton of coal) to: for Be—1.0, Se—3.0, Mn—83.7, Th—441.2, that is, the admissible ("nondangerous") level of concentration of these CE in coals in comparison with the conditions for traditional coal dust combustion increases by a factor of 1.25, 1.58, 2.24 and 1.18 respectively.

The final objective and result of the predictive estimate of the level of atmospheric pollution by the effluent of enterprises (in our case—coal-burning TEPP) is computation of the social and economic loss borne by the population, agricultural fields and industrial enterprises. The norm-setting documents adopted in the RF Ministry of Electric Power regulate the method for making such computations [7]. This method also can be used in the case of predictive estimates of the effluent of planned or reconstructed power plants on the basis of the approaches developed in this article.

In the Coal Geology Laboratory of the Geology Faculty of Rostov State University personal computer software has been developed for use of geological prospecting data for predicting the atmospheric pollution level in the neighborhood of coal-burning TEPP arising as a result of the discharge of sulfur and nitrogen oxides, solid particles and CE in smoke effluent, for estimating dangerous concentrations of CE in coals arriving at GRES, and also for estimating the economic loss inflicted on the environment. The program ensures the possibility of plotting predictive maps of the fields of concentration of an atmospheric pollutant when there are average and dangerous wind speeds, with output to a monitor screen or printer. In the interests of the branch the program can be replicated in a certain number of copies and used to meet the needs of interested geological organizations.

In summarization the following conclusions can be drawn.

1. The described methods for evaluating dangerous concentrations of CE in coals result in numerical estimates considerably differing from the standard estimates now used in carrying out geological prospecting work for coal [8].
2. The mean concentrations of CE in coals of the Eastern Donbass were determined. They are (in g/ton): Be—2.5; Mn—88.9; Se—6.8; Th—11.7.
3. The results of the study indicate that the dangerous concentrations of contaminating elements in the coals of the Eastern Donbass can be estimated (in g/ton) as: Be—0.8; Se—1.9; Mn—37.3; Th—373.3.
4. The mean concentrations of Be, Mn and Se in the coals of the Eastern Donbass exceed the dangerous levels.
5. In the association of the studied CE the emphasis must be on Th. This element, being a natural radio nuclide, must be examined relative to its radiation impact. With such an approach the mean Th concentrations in the coals of the Eastern Donbass considerably exceed the dangerous levels.

Bibliography

1. Berlyand, M. Ye., *Sovremennyye problemy atmosfery diffuzii i zagryazneniya atmosfery* (Current Problems in Atmospheric Diffusion and Atmospheric Pollution), Leningrad, Gidrometeoizdat, 1975.
2. Berlyand, M. Ye., Temikhovich, Ye. L. and Demyanovich, V. K., Some timely problems in research on atmospheric diffusion, *TR. GOS. GEOFIZ. OBSERVATORII* (Transactions of the State Geophysical Observatory), No 172, pp 3-22, 1965.
3. Bertshnayder, B. and Kurfyurst, I., *Okhrana vozdukhonogo basseyna ot zagryazneniya* (Air Basin Protection Against Pollution), *Tekhnologiya i kontrol*, Leningrad, Khimiya, 1989.
4. Burtseva, L. V., Lapenko, L. A., Kononov, E. Ya., Yushkan, Ye. I., et al., Background content of lead, mercury, arsenic and cadmium in natural media (based on world data), *MONITORING FONOVOGO ZAGRYAZNENIYA PRIRODNYKH SRED* (Monitoring Background Pollution of Natural Media), Leningrad, No 7, pp 23-56, 1991.
5. Filov, V. A. (editor), *Vrednyye khimicheskiye veshchestva. Neorganicheskiye soyedineniya elementov I-IV grupp* (Hazardous Chemical Substances. Inorganic Compounds of Elements of Groups I-IV), Leningrad, Khimiya, 1988.
6. Filov, V. A. (editor), *Vrednyye khimicheskiye veshchestva. Neorganicheskiye soyedineniya elementov V-VII grupp* (Hazardous Chemical Substances. Inorganic Compounds of Elements of Groups V-VII), Leningrad, Khimiya, 1989.
7. *Vremennaya tipovaya metodika opredeleniya ekonomicheskoy effektivnosti osushchestvleniya prirodno-okhrannykh meropriyatiy i otsenka ekonomicheskogo ushcherba, prichinyayemogo narodnomu khozyaystvu zagryazneniyem okruzhayushchey sredy* (Interim Standard Method for Determining Economic Effectiveness of Implementation of Environmental Protection Measures and Evaluation of Economic Loss Inflicted on Economy by Environmental Pollution), Moscow, SPO "Soyuztekhnenergo," 1983.
8. *Instruktsiya po izucheniyu toksichnykh komponentov pri razvedke ugolnykh i slantsevykh mestorozhdeniy* (Instructions on Study of Toxic Components in Exploration of Coal and Shale Deposits), Moscow, GKZ pri Sovete Ministrov SSSR, 1982.
9. Kizilshteyn, L. Ya., Concentration of contaminating elements on surface of solid particles of smoke plumes of coal-burning thermal electric power plants, *KHIMIYA TVERDOGO TOPLIVA* (Chemistry of Solid Fuel), No 6, pp 91-96, 1993.

10. Kizilshteyn, L. Ya., Levchenko, S. V. and Peretyatko, A. G., Formation of gaseous phase of contaminating elements during combustion of coals at thermal electric power plants, *KHIMIYA TVERDOGO TOPLIVA*, No 6, pp 136-139, 1990.
11. Kizilshteyn, L. Ya. and Peretyatko, A. G., Contaminating elements in combustion products of Donets ASH in CBL boilers (based on results of stand tests), *KHIMIYA TVERDOGO TOPLIVA*, No 6, pp 82-86, 1992.
12. Kizilshteyn, L. Ya., Peretyatko, A. G. and Gofen, G. I., Paleogeographic patterns in distribution of contaminating elements in coal strata, *LITOLOGIYA I POLEZNYYE ISKOPAYEMYYE*, No 3, pp 129-134, 1988.
13. Kizilshteyn, L. Ya., Peretyatko, A. G. and Gofen, G. I., New data on distribution of contaminating elements among coal matter components, *LITOLOGIYA I POLEZNYYE ISKOPAYEMYYE*, No 6, pp 32-35, 1989.
14. Kizilshteyn, L. Ya., Peretyatko, A. G. and Gofen, G. I., Contaminating elements in coals, combustion products, soils and atmosphere in neighborhood of thermal electric power plant, *IZV. SEVERO-KAVKAZSKOGO TSENTRA VYSSHEY SHKOLY. YESTESTV. NAUKI* (News of the Northern Caucasus Higher Educational Center. Natural Sciences), No 2, pp 42-52, 1990.
15. Kizilshteyn, L. Ya., Peretyatko, A. G., Chistilina, G. A. and Savenko, I. D., Tests of coals using laboratory fire stands for choice of direction in combined use of combustion products and ecologic predictions based on materials from geological prospecting work, *KHIMIYA TVERDOGO TOPLIVA*, No 2, pp 18-26, 1994.
16. Metodika rascheta kontsentratsiy v atmosfernom vozdukh vrednykh veshchestv, sodержashchikhsya v vybrosakh predpriyatiy (OND-86. Goskomgidromet) (Methods for Computing Atmospheric Concentrations of Hazardous Substances Present in Effluent of Enterprises (National Norm-Setting Document-86, State Committee for Hydrometeorology and Environmental Monitoring). Leningrad, Goskomgidromet, 1987.
17. Perelman, A. I., *Geokhimiya* (Geochemistry), Moscow, Vysshaya shkola, 1979.
18. Filov, V. A. (editor), *Radioaktivnyye veshchestva* (Radioactive Substances), Leningrad, Khimiya, 1990.
19. Rovinskiy, F. Ya., Petrukhin, V. A., Vizhenskiy, V. A., et al., Background content of trace elements in natural media (based on world data), in: *MONITORING FONOVOGO ZAGRYAZNENIYA PRIRODNYKH SRED*, Leningrad, No 4, pp 3-30, 1987.
20. *Energetika i okruzhayushchaya sreda* (Power Production and the Environment), Moscow, Energiya, 1979.
21. Yudovich, Ya. E., Kertis, M. P. and Merts, A. V., *Elementy-primesi v iskopayemykh uglyakh* (Contaminating Elements in Fossil Coals), Leningrad, Nauka, 1985.

Comparative Analysis of Intraannual Variation of Total Ozone Content Using Data From Satellite and Surface Observations

957A0367A Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sept-Oct 94 (manuscript received 21 Apr 94) pp 9-16

[Article by I. V. Dalyuk and O. M. Pokrovskiy, Main Geophysical Observatory imeni A. I. Voyeykov, St. Petersburg; UDC 528.81:551.510.534]

[FBIS Abstract] An analysis was made of the year-to-year variability of the total ozone content for individual months of the year. A study also was made of the characteristics of the intramonthly changes in the total ozone content for the three-month intervals March-May and October-December. The initial data used were series of daily readings from surface observations at Voyeykovo (59°58'N, 30°18'E) during 1973-1993 and corresponding daily satellite data registered by a TOMS [Total Ozone Mapping Spectrometer] instrument for the point 60°N, 30°E, making it possible to compare the two types of observations. The first stage in the work was computation of the mean monthly values for each year and an analysis of the year-to-year values for the corresponding months. The next stage was a study of the statistics of the observed diurnal quantities within the spring and autumn months. The effectiveness of an approximation of intramonthly variations of total ozone content was demonstrated using the Karunen-Loew method. An interdependence was found between the intramonthly variations of total ozone content for adjacent months of the year: March-April, October-November. The stability of the base functions of the approximation is demonstrated with respect to the form and volume of archival observational information. It is proposed that this methodological approach be used for predicting the course of total ozone content for 1-2 months in advance. Despite these results no great progress can be anticipated in solving the problem of predicting total ozone content because during recent years, especially in 1993, there has been a rapid restructuring of the intraannual variation of total ozone content. Figures 5; tables 2; references: 6 Russian.

Radar Measurements of Mesoscale Fields of Ocean Currents Made Using Almaz-1 Spacecraft SAR

957A0367B Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sept-Oct 94 (manuscript received 16 Nov 93, after revision 16 May 94) pp 28-38

[Article by S. V. Pereslegin, A. M. Korolev (deceased), M. N. Marov, S. A. Mishin, K. M. Shulika, A. Yu. Ivanov and V. V. Zaytsev, Oceanology Institute imeni P. P. Shirshov, Russian Academy of Sciences; UDC 528.873.041.1:551.465]

[FBIS Abstract] A method is given for measuring small-scale velocity fields of ocean currents on the basis of an analysis of the Doppler spectrum of signals from a satellite-borne synthesized aperture radar (SAR). A small part of a radar frame registered by the SAR aboard the Almaz-1 satellite during sounding of the surface of the Western Atlantic in the neighborhood of the Gulf Stream was subjected to trial processing. It is theoretically demonstrated and experimentally confirmed that there is a possibility of measuring the submesoscale velocity field of strong oceanic currents by using an orbital SAR with a threshold response of about 0.3 m/s with an averaging area of about 1 km². Retrieval of the velocity portrait in the absence of external precise calibrations requires an extremely high accuracy in reading orientation angles and their slow variations. In order to obtain velocity portraits of ocean currents with an adequate information yield it is necessary to use the entire width of the SAR scanning swath (about 40 km). It is important to continue theoretical and experimental studies for developing methods for the detection and suppression of natural velocity errors arising when estimating current velocity which are attributable to local variations of the field of small waves. Figures 5; references 8: 6 Russian, 2 Western.

Automating Procedure for Search for Centers of Clusters in Problems of Segmentation of Half-Tone Images

957A0367C Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sept-Oct 94 (manuscript received 22 Nov 93, after revision 29 Apr 94) pp 51-57

[Article by Ye. M. Dondik and V. P. Tikhonov, State Electronics Academy, Ryazan; UDC 681.3:538.854.2]

[FBIS Abstract] Problems relating to the procedure of search of criterial space for the centers of clusters by preliminary smoothing with allowance for the quantitative relations between the brightness levels of the video information and the averaged values of the characteristic indicators are discussed. An algorithm is proposed which includes the formation of a matrix of indicators whose elements are computed with allowance for the weighted contribution of the indicators and a subsequent iterative procedure for search for a conditional extremum using the test of minimizing of the sum of the intragroup dispersion or maximizing of total intergroup dispersion. A segmentation algorithm transforming criterial space into a set of

vectors ordered in brightness, forming a matrix of indicators, is outlined. Each matrix element is equal to the value of the indicator for the corresponding brightness, averaged for the set. The totality of the vectors forming the matrix is an informational base for implementing an automatic procedure for finding the centers of clusters using the test of a minimum of intragroup dispersion or the maximum of intergroup dispersion, mentioned above. In a detailed discussion of the clusterization algorithm it is shown that the introduction of procedures for an automated search for the centers of clusters not only simplifies the dialogue mode for the user, but also makes it possible to reduce the influence of subjective factors in the last, most serious stage in making decisions. The use of the matrix of indicators with normalization of their parameters results in a decrease in dispersion when determining the boundaries of the segments and makes possible a directed search for the centers of the clusters. The results of experimental checking of the algorithm using a real multiband image confirmed its effectiveness and applicability to solution of specific practical segmentation problems. Figures 3; tables 3; references: 9 Russian.

Evaluating Possibility of Increasing Ocean Surface Temperature Maps by Joint Use of On-Line Shipboard and Satellite Data

957A0367D Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 94 (manuscript received 26 Apr 94) pp 58-62

[Article by V. P. Leventuyev, Moscow State University imeni M. V. Lomonosov; UDC 528.873.041.3:551.501]

[FBIS Abstract] In Russia OST (ocean surface temperature) maps are presently prepared using two main types of information. The mean statistical accuracy of such data, based largely on shipboard observations, is rather low (about 1.5-2°C) with an extremely nonuniform distribution over the area of the ocean. These data, by objective analysis methods, are reduced to the points of intersection of a regular grid. Data also are available from Meteor-3 satellites which carry single-channel IR radiometers, but these do not make possible effective elimination of the variable contribution of the atmosphere and OST can only be retrieved with an accuracy considerably below about 3°C. Ways have been sought to increase this accuracy by the use of additional information. A simple model of joint shipboard and satellite measurements in an on-line mode was used in deriving expressions making it possible to compute estimates of OST values and their accuracy (dispersion) which can be considered optimum when taking a priori climatic information into account. In the model use is made not of direct shipboard and satellite measurements, but the generalized results of measurements and processing (values reduced to the points of intersection of a regular grid). The derived analytic formulas are used in effective estimates of OST values and may make possible an increase in the accuracy of the corresponding maps. References 4; references 4: 3 Russian, 1 Western.

Models of Global Communication Satellite Systems in Elliptical Orbits

957A0367E Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 94 (manuscript received 21 Feb 94) pp 70-77

[Article by V. I. Zabotin, Kazan State Technical University imeni A. N. Tupolev; UDC 629.76/78.015.7]

[FBIS Abstract] This communication is in essence a continuation of an earlier article in this journal [Sh. I. Galiyev and V. I. Zabotin, "Models of satellite global communication systems and methods for analysis and synthesis of their structures" (No 5, pp 66-74, 1993)]. New models are now proposed for ensuring exchange of information between satellites, essential for establishing global communication systems. This is exemplified by the relationships between two satellites designated C_j and C_k . In formulating these models it is essential to derive the pertinent cycle indicators and prove the correctness of the Lipshits condition for them (the most important information concerning the Lipshits function is reviewed). Another highly important element in such an examination is the visibility function v_{jk} , indicative of those conditions for visibility between C_j and C_k with which reciprocal radio communication is possible between them. It is the visibility function which is assigned the greatest importance. Three different models for special situations are proposed and discussed in detail. Estimates of the Lipshits constant increase with an increase in orbital eccentricities, exerting a negative influence on the time for computing the zeroes of the cycle indicators. As an example a table is given of the results of a numerical experiment for finding the zeroes of the visibility function for two satellites with stipulated orbital parameters for 24-hour orbits. Table 1; references 4; 3 Russian, 1 Western.

Morphostructural Interpretation of Data Obtained by Radar Sensing From Almaz-1 Spacecraft (Exemplified by Shelf of Helgoland Bay in North Sea)

957A0367F Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 94 (manuscript received 29 Apr 94) pp 87-93

[Article by I. G. Avenarius, A. Yu. Ivanov, P. A. Shirokov and V. Ye. Shkarin, Aerogeologiya State Scientific Production Enterprise; Machine Building Scientific Production Association; UDC 551.446.8:629.78]

[FBIS Abstract] A survey of the mouth of the Elbe River using a spaceborne SAR [Synthetic Aperture Radar] made it possible to obtain valuable material for an analysis of the structure and morphology of the complex dendritic system of tidal trenches on the North Sea shelf. The flooding and drying out of the coastal zone of the shelf as a result of the regular cycle of incoming and outgoing tides makes it possible to study both the geomorphological structure of the floor and its morphostructure. With the going out of the tide a dendritic

network of channels and trenches is registered on the radar image and this pattern is formed by water flows on the desiccating flats and by the wind generating wave roughness on the sea surface. Radar remote sensing has a high sensitivity to surface wave roughness (ripple waves) and the ripples in turn are sensitive to the dynamics of the sea surface layer. In tidal seas a radar survey therefore makes it possible to register phenomena and processes caused by the dynamics of tidal currents. Changes in sea surface roughness associated with change in the velocities of these currents and their gradients in many cases are caused by the orography of underwater relief. Because of this the radar image of the dendritic structure of tidal trenches is more detailed and structured than on space images registered in the visible range. Study of the outlines, morphology and orientation of the tidal trenches made it possible by morphostructural analysis methods to discriminate the newest morphostructures of different orders as well as lineaments expressed in the underwater relief by linear segments of trenches or a series of their kneelike bends. A comparison of radar image analysis data with published materials makes it possible to assert that a high-resolution radar survey makes it possible to study underwater relief forms with a detail and accuracy which it is considerably more difficult and sometimes impossible to achieve when using other methods. Figures 3; references 9: 6 Russian, 3 Western.

Mathematical Models of Landscape Patterns As One of Bases for Quantitative Methods for Interpreting Aerospace Survey Materials

957A0367G Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 94 (manuscript received 11 Feb 94) pp 94-103

[Article by A. S. Viktorov and S. Yu. Tsirinskaya, Scientific Geoinformation Center, Russian Academy of Sciences; UDC 528.8.041:551.46.06]

[FBIS Abstract] With several natural assumptions on the formation of eolian ridged plains it was found that the landscape structure of these plains conforms to two fundamental equations forming the basis for a mathematical model. On the basis of this model a number of conclusions are drawn concerning the behavior of various quantitative parameters characterizing the image: distribution of the lengths of complex ridges, distribution of singularities and distribution of lengths between intersections of ridges by a random transect. The model was empirically checked in test sectors. The model made it possible to conclude that there is a Poisson distribution of singularities in different areas. An effective interpretation test is proposed for the interpretation of the corresponding structural geology. The formulated problem is reduced to an equality of two mean samples, each of which represents an area. There is an extremely perfect statistical test for checking the equality of the means: an unbiased test applied to criteria based on the uniformly "strongest" region. This test for checking the

equality of the means essentially involves checking to see that the sum of the number of initial points is binomially distributed between two samples with different probabilities. Thus, the procedure for determining an anomaly is reduced to the following: determination of the number of initial points in a trial area, computation of the sum of the number of points in the trial and reference areas (n_0 and n), comparison of the sum (n_0 and n) and the signs test for $N(n_0, n)$. In a case when the sum exceeds the test value the sector occupied by the trial area must be regarded as an anomaly. The anomaly is interpreted on the basis of a comparison of the anomalous sectors with geophysical and drilling data. As demonstrated in the example of eolian ridged plains, the construction of mathematical models of landscape patterns in different types of areas makes it possible to establish a basis for solving important problems in quantitative interpretation of space photographs. Figures 2; tables 3; references 11: 9 Russian, 2 Western.

Experience in Use of Multiband Space Information for Evaluating Condition of Pastures and Fields of Agricultural Crops in Rostov Oblast

957A0367H Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 94 (manuscript received 19 Apr 94) pp 104-111

[Article by L. A. Shlyakhova, V. I. Povkh, P. D. Kovneristov, V. V. Asmus, N. V. Yeliseyev and A. V. Kupyanskiy, Don Ecologic Center, Rostov-na-Donu; Planeta Scientific Production Association, Moscow; UDC 528.75:629.78]

[FBIS Abstract] Thematic processing of high-resolution scanner information was used in plotting sketch maps for on-line evaluation of the condition of pastures and plantings of winter wheat in the southeastern part of the Rostov region. The initial materials used were data from a space survey from the Kosmos-1939 satellite obtained using an MSU-E camera and registered in two spectral channels 0.5-0.6 and 0.8-0.9 μm . Although the optimum survey period for grasses and winter wheat is the second half of April, heavy precipitation in the second half of the spring of 1993 made it necessary to use July observations, but that year July conditions corresponded to typical April conditions. At more or less the same time as the space surveys on-line comparative information was obtained on test farms concerning the condition of pastures and geobotanic parameters, key sectors were selected corresponding to definite classes of the beating down of pastures and these data were referenced to the space photograph. The formed space videoimage of farms was broken down into fragments for subsequent automated processing, carried out in an interactive mode. The pattern recognition and scene analysis techniques used in this interpretation are described in detail. Four types of pasture condition could be discriminated on the basis of beating down of grass stands, as were three gradations of the condition of fields of winter grains during early spring, confirmed by field data obtained in the test sectors. Figures 7; table 1; references: 7 Russian.

Coordinate Systems in Space Photogrammetry

957A0368A Moscow GEODEZIYA I KARTOGRAFIYA in Russian No 10, Oct 94 pp 26-31

[Article by Yu. S. Tyuflin; UDC 528.72:516]

[FBIS Abstract] The importance of coordinate systems and their transformations as the basis of space photogrammetry theory and practice is reviewed. The fundamental coordinate systems (and their interrelations) which are used in the processing of materials from a space survey of the Earth's surface are summarized. Different variants of survey camera coordinate systems can be used, depending on the geometry of image formation and type of survey apparatus. The origin of coordinates of the system for all variants is at the survey camera center of projection but the directions of the coordinate axes may be oriented differently. The following systems are examined: survey camera coordinate system for frame survey; space vehicle coordinate system; geocentric geoequatorial coordinate system for standard epoch T_0 ; geocentric geoequatorial coordinate system for epoch T_1 ; object-centered geoequatorial coordinate system for epoch T_1 ; object-centered orbital coordinate system; geocentric orbital coordinate system for current moment in time t ; object-centered orbital coordinate system at moment in time of transit of spacecraft through orbital pericenter of survey orbit; geocentric orbital coordinate system (of two types); object-centered orbital coordinate system at time of transit of spacecraft through ascending node of spacecraft orbit at Earth's equator. The particular features and special applications of these systems are individually examined. The considered coordinate systems constitute an integral part of space photogrammetry theory and are needed when writing algorithms and in preparing software and technologies for the processing of aerospace photographs when compiling and revising topographic maps and in coordinate referencing of space survey materials.

State of the Art in Ecologic Mapping

957A0368B Moscow GEODEZIYA I KARTOGRAFIYA in Russian No 10, Oct 94 pp 38-42

[Article by N. A. Zherebtsova; UDC 528.94(470)]

[FBIS Abstract] In ecologic mapping it is now possible to distinguish three major directions: geocentric, anthropo- or democentric, and biocentric, each of which reflects the characteristics and aftereffects of interaction between an object and its environment; in the first nature is the central focus of attention, in the second it is man and in the third (which some do not choose to recognize) it is biosystems. The maps based on such approaches are called geo-, anthropo- and bioecologic and within each of these classes there are subclasses based on purpose and time interval, category of users, purposes of mapping, scale and other considerations. Ecologic reality is depicted most fully and precisely by complex (multifactor) maps which afford a possibility

for fully taking into account the changes in nature and their influence on man or the influence of man on changes in nature. Such maps vary with respect to the degree of generalization of the material, categories of users, time of preparation and other factors. This approach, first appearing in 1989, has become quite popular and trends can now be defined. Many single-subject maps are available which can be used in the preparation of complex maps. Work in the anthropocentric direction is predominating over the geocentric approach. This type of work dictates revision of the structure of traditional map legends because often they must be quite detailed and descriptive, particularly since much pertinent terminology has not yet been fully defined; it is mandatory that all terms be explained in the legend. All references to source materials must indicate the pertinent date. Inset maps or other techniques must be employed to indicate the level of reliability of information for different parts of the mapped area, accuracy of measurement methods and quality of monitoring, without which information the map is of little value. Tables 2; references: 10 Russian.

Low-Frequency Underwater Acoustic Transducers of Small Wave Dimensions Based on Active Discrete Structures

957A0366A Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA: FIZIKA, ASTRONOMIYA in Russian Vol 35 No 6, Nov-Dec 94 pp 75-85

[Article by P. N. Kravchun, Moscow State University; UDC 534.232]

[FBIS Abstract] The results of theoretical and experimental studies of small underwater hydroacoustic emitters and detectors constructed on the basis of piezoelectric discrete structures with concentrated parameters, suitable for operation in a multifrequency mode, free of most of the shortcomings of traditionally used transducers, are presented. Emphasis is on work done at Moscow University. A transducer model is outlined which affords broad possibilities for choosing a specific variant of the elementary structural components (piezoelectric inertial and passive elastic elements). The maximum size of the detectors is 5 cm; response attains 600 $\mu\text{V}/\text{Pa}$ with a detector mass 140 g and a piezoelement capacitance 830 pF. Research was in the laboratory, in Lake Ladoga and in the Black Sea using single- and three- element emitters based on structures of the band and low-frequency electromechanical filters type, as well as single- and two-element detectors based on the low-frequency filter principle. The resonance frequencies of the piezoceramic transducers fell in the range 140 Hz-10 kHz. A method was developed for finding the parameters of the transducer oscillatory system for stipulated resonance frequencies using special nomograms, making repeated numerical solution of the inverse problem unnecessary. The principal relations describing the wave process in such structures applicable to radiation and

reception problems are given, as well as the characteristics of specific one-, two- and three- frequency transducers operating under in situ experimental conditions. Feasible ways to increase the efficiency of transducers of small wave dimensions are briefly discussed. Figures 7; references 17: 14 Russian, 3 Western.

Algorithm for Determining Direction to Source by Small Low-Frequency Array in Presence of Ambient Noise

957A0366B Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA: FIZIKA, ASTRONOMIYA in Russian Vol 35 No 6, Nov-Dec 94 pp 85-93

[Article by K. A. Pestov and O. S. Tonakanov, Moscow State University; UDC 534.88]

[FBIS Abstract] Earlier publications by Moscow University specialists revealed the possibility of reducing the influence of reverberation noise by correlation processing when using a definite reciprocal orientation of reception channels and the radiation axis: there are optimum variants of the positioning of dipole hydrophones relative to the radiation axis. This communication is a generalization of the results of earlier research on use of statistical methods for the reception and processing of signals picked up by vectorial-scalar transducers in the presence of ambient noise in the ocean on the basis of models, both those published by others and those developed at the university, applicable to a multi-component detector of acoustic velocities positioned at the same point as a pressure detector. An appropriate data processing algorithm is written, since the lack of such an algorithm has represented a weak link in profiting from the earlier research. The algorithm is based on the maximum likelihood method and affords a possibility for determining directions to the sound source under ambient noise conditions. Application of the algorithm is investigated under different conditions. A comparison with the Aki-Richards method used in seismology for determining angular coordinates is given and it is shown that the three-channel system proposed for this same purpose, based on a multichannel velocity detector with a system including both velocity and acoustic pressure channels, with application of the newly proposed algorithm, is superior in all respects. Figures 5; references: 11 Russian.

Possibility of Identification of Radioactive Tracks of Nuclear Explosions and Reconstruction of Irradiation Doses Received by Population by Analysis of Long-Lived Radionuclides

957A0278A Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 12, Dec 94 (manuscript received 20 Sep 94) pp 5-14

[Article by Yu. A. Izrael, Ye. D. Stukin and Yu. S. Tsaturov, Russian Federal Service for Hydrometeorology and Environmental Monitoring; this article in the form of a report was presented at an international conference in Barnaul in October 1994; the first paragraph is an abstract; UDC [504:064:621.039.9].004.69]

[FBIS Translated Text] *In order to identify the radioactive tracks of old nuclear explosions and reconstruct the irradiation doses in their territories it is proposed that use be made of aerosol particles forming in the explosion fireball and their specific radionuclide composition. A number of long-lived radionuclides were theoretically selected and experimentally determined for tracks formed 25-45 years ago. From the gamma spectra of aerosol particles from the explosions of 1949 and 1953 it was possible to determine not only cesium-137, but also cobalt-60, europium-152, -154, -155 and americium-241. The ratio of the indicated isotopes provides considerable information for identification of individual tracks and computation of the corresponding irradiation doses along them.*

During recent years there has been great interest in reconstructing the doses of internal and external irradiation along the tracks of nuclear explosions set off many years ago. In reconstructing the irradiation doses on radioactive tracks forming decades ago various approaches [2, 4] have been employed, including:

- use of archival roentgenometric data;
- use of a great number of existing mathematical models for constructing the extension of the track (using archival documents) in those territories where radiation data were not registered immediately after track formation (that is, in the absence of archival data on determination of radiation conditions in these territories);
- use of data on long-lived radionuclides—for all practical purposes only for Cs-137 and Sr-90 (the results of a careful aerial gamma-spectral survey for determining Cs-137 or taking soil samples with a subsequent analysis, including a layer-by-layer analysis for Cs-137 and Sr-90, were used) with an additional analysis of a very small number of samples for Pu-239, -240.

However, in this work researchers met with considerable difficulties, which involved the following:

- an inadequacy of archival data on measurements of radioactivity and meteorological observations;
- considerable distortions of the direction of the "retrieved" tracks due to inaccuracy of meteorological data and uncertainty of the radioactivity source,

including uncertainty with respect to the height and power of the explosion, and also relevant to the size distribution of radioactive particles;

- presence of a considerable relative quantity of Cs-137 and Sr-90 of global origin (and possibly, also simultaneously layers from several nuclear explosions). All these complexities result in fundamental restrictions on the correct reconstruction of the irradiation doses on radioactive tracks after the elapsing of many years from the time of the nuclear explosions.

What has been said is illustrated in a simple example. We will assume that we measure the density of terrain contamination only from Cs-137. If at the present time in any region (such as Altay Kray) we register a density of contamination from Cs-137 of 100-300 mCi/km² (see Fig. 1) and we assume that the mean density of contamination from global fallout is 80 mCi/km², the remaining 20-220 mCi/km² can be assigned to local nuclear explosions, and in particular (for the Altay region) to the first nuclear explosion set off in the USSR in August 1949, movement of whose cloud was directed toward Altay Kray. However, for a specific point in a territory or populated place the contamination might not be from a specific explosion, but only (or partially) from global fallout, the range of whose values through the territory of the former Soviet Union for Cs-137 was 10-400 mCi/km². For the example cited above it is easy to calculate that the external dose on the track of the nuclear explosion 50 years after the time of fallout, with allowance for the enormous quantity of short-lived radionuclides at the initial time, will exceed by a factor of 10 the dose from the global fallout with identical levels of the density of contamination by Cs-137 at the present time (100-300 mCi/km²). The dose of external radiation from global fallout will be less than 0.5 R, but on the track from the nuclear explosion for the indicated case—25-30 R.

In order to eliminate the arising uncertainties it is necessary to find additional individual indicators of the old radioactive track making it possible to identify it and to discriminate the intensity of the dose from different radionuclides, especially Cs-137, from a particular explosion, to ascertain the individual characteristics of the track of each explosion, which is especially important with a superposition of the tracks from different explosions and with a strong background influence of global fallout.

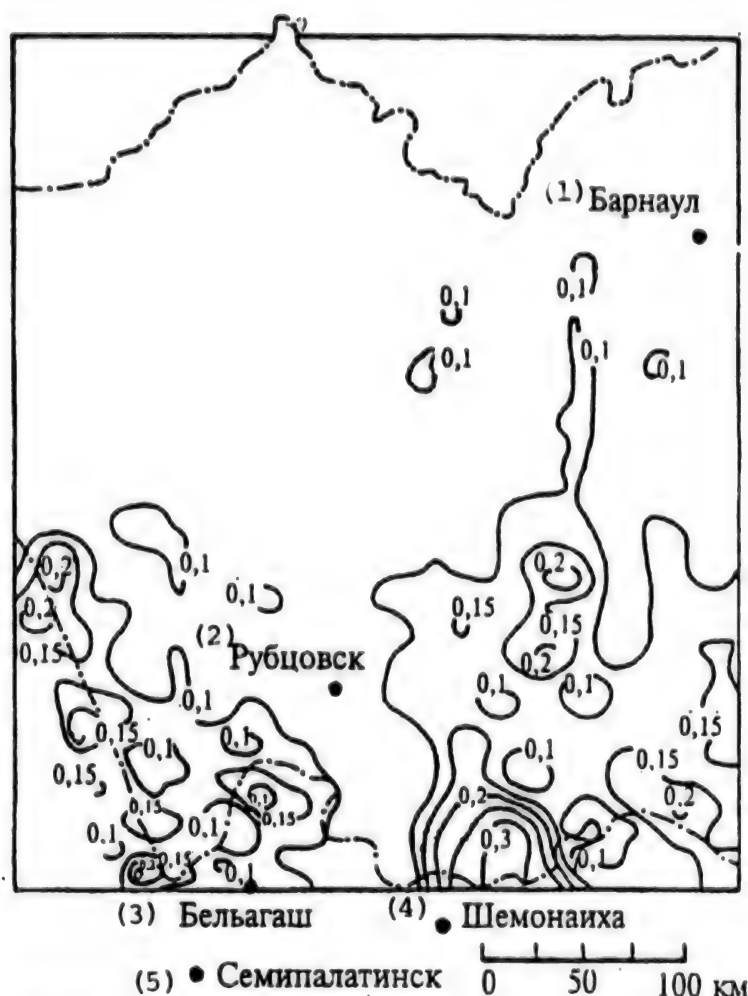


Fig. 1. Sketch map of radioactive contamination of Altay Kray by cesium-137 (Ci/km²)

Key: 1. Barnaul 2. Rubtsovsk 3. Belagash 4. Shemonaikha 5. Semipalatinsk

Table 1. Long-lived (with half-life greater than 4 years) radionuclides—fission fragments

Fission products of uranium-235 by thermal neutrons [1]			Fission products of plutonium-239 by fission spectrum neutrons [3]		Possibility of use
radionuclide	half-life, years	yield, %	half-life, years	yield, %	
Se-79	6×10^4	0.056	6.5×10^4	0.066	Possible
Kr-85	10×10^6	0.293	10.6	0.145	None
Rb-87	5×10^{10}	2.49	-	0.018	None
Sr-90	28	5.77	28	2.14	Realistic
Zr-93	1.1×10^6	6.45	9.5×10^5	3.33	With difficulty
Nb-93 ^m	12	6.45	3.7	3.33	Possible
Tc-99	2.1×10^5	6.06	2.1×10^5	6.10	Possible
Pd-107	7×10^6	0.19	7×10^6	3.95	With difficulty
In-115	6×10^{14}	0.0097	6×10^{14}	0.064	None

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Table 1. Long-lived (with half-life greater than 4 years) radionuclides—fission fragments (Continued)

Fission products of uranium-235 by thermal neutrons [1]			Fission products of plutonium-239 by fission spectrum neutrons [3]		Possibility of use
radionuclide	half-life, years	yield, %	half-life, years	yield, %	
Sn-121 ^m	5	0.015	20	0.0004	Possible
Sn-126	2×10^5	-	2×10^5	0.075	Possible
I-129	1.7×10^7	0.8	1.6×10^7	2.98	Possible
Cs-135	2.6×10^6	6.41	2×10^6	6.56	With difficulty
Cs-137	30	6.15	30	6.83	Realistic
Nd-144	5×10^{15}	5×10^{15}	Stable	3.20	None
Sm-147	1.3×10^{11}	2.36	Stable	2.05	None
Sm-151	80	0.44	90	0.884	Realistic
Eu-152	-	-	-	-	Realistic
Eu-154	-	-	16	0.0007	Realistic
Eu-155	4	0.033	1.7	0.249	Realistic

Note. The dash denotes absence of data in the specific bibliographic source [3] on the presence of Eu-152 and Eu-154 in fission fragment products. "Stable," in the bibliographic source used, means that this radionuclide is regarded as nonradioactive.

The authors feel that such individual characteristics are:

- 1) the particular characteristics of the aerosol particles (for each explosion there are individual characteristics of radioactive particles, and as is entirely evident, each particle belongs to only one specific explosion);
- 2) the radionuclide composition of these particles also is distinctive for each explosion, especially if these individual characteristics are examined simultaneously with the change in contamination characteristics at great distances from the source, that is, when the discrimination of individual particles is difficult; in this case it is desirable that the identity of the explosion be determined from the ratio of the characteristic radionuclides in soil samples.

For old tracks of nuclear explosions it is necessary to determine the maximum number of long-lived radionuclides in particles and soil samples and to compute their ratios. Such a determination is a complex operation, but it is possible. These possibilities are examined in this article. Similar work also must be done with samples of global fallout for comparative purposes.

As already noted, using the determined ratios of radionuclides it is possible to identify different tracks and thereafter to reconstruct their necessary characteristics.

In the first stage we used an approach based on measurement primarily of Cs-137 and use of archival roentgenometric and meteorological data for reconstructing old tracks of nuclear explosions and atomic accidents set forth in [4]. Next we began work by the method described above, including a search for radioactive particles from nuclear explosions, determination of possible long-lived radionuclides for the identification of tracks and an attempt at real measurements of these radionuclides, as well as an initial analysis for finding the

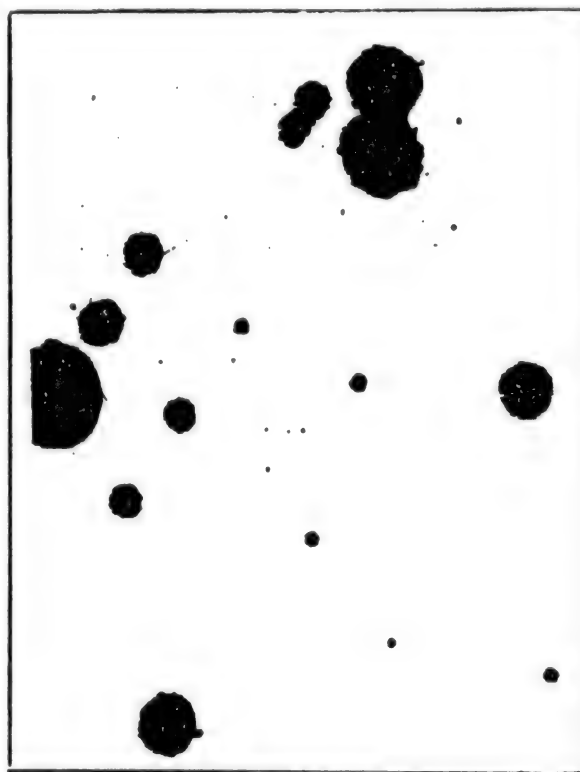


Fig. 2. Sample of radiography of large fused aerosol particles.

characteristic ratios of different nuclear explosions. The article describes the results of this work. Radioactive particles were found (sampled) on two tracks of "old" nuclear explosions set off at the Semipalatinsk test site: the atomic (plutonium) explosion set off on 29 August

1949, with a power of 20 kt on a tower, and a thermonuclear explosion set off on 12 August 1953 with a power of about 430 kt, also on a tower.

Figure 2 shows an example of radiography of some large (several millimeters in diameter) fused aerosol particles. This figure shows the possibility of discriminating radioactive particles by such a method. Table 1 lists all the long-lived (with a half-life of more than 4 years) radionuclides known to us forming as a result of fission of

nuclear fuel (fission fragment activity group); Table 2 lists the radionuclides induced by explosion neutrons on ground elements or the explosive device itself (some radionuclides are listed in both tables).

Tables 1 and 2 indicate for the time being the approximate possibility (expert evaluation) of use of most of the enumerated radionuclides for identifying the tracks of old nuclear explosions.

Table 2. Long-lived (with half-life of more than 4 years) radionuclides induced by nuclear explosion neutrons

Radionuclide	Half-life, years	Formation reaction	Possibility of use
Al-26	7.3×10^5	Al-27 (n,2n)	Slight
Cl-36	3.01×10^5	Cl-35 (n, γ)	Slight
Ca-41	1.03×10^5	Ca-40 (n, γ)	Slight
Ni-59	7.6×10^4	Ni-58 (n, γ)	Possible
Co-60	5.24	Co-59 (n, γ)	Realistic
Ni-63	100	Ni-62 (n, γ)	Possible
Se-79	6.0×10^4	Se-78 (n, γ)	Slight
Zr-93	1.1×10^6	Zr-92 (n, γ)	Slight
Nb-93 ^m	12	Nb-93 (n,n')	Possible
Nb-94	2×10^4	Nb-93 (n, γ)	Possible
Mo-93	3500	Mo-92 (n, γ)	Possible
Sn-121 ^m	5	Sn-120 (n, γ)	Possible
Sm-151	80	Sm-150 (n, γ)	Possible
Eu-150	36	Eu-151 (n,2n)	Possible
Eu-152	13.5	Eu-151 (n, γ), Eu-153 (n,2n)	Realistic
Eu-154	16	Eu-153 (n, γ)	Realistic
Ho-166 ^m	1200	Ho-165 (n, γ)	Possible
Hf-178 ^m	31	Hf-177 (n, γ)	Possible
Re-186 ^m	2×10^5	Re-185 (n, γ)	Slight
Ir-192 ^m	240	Ir-191 (n, γ)	Possible
Pt-193	60	Pt-192 (n, γ)	Possible
Pb-205	1.5×10^7	Pb-204 (n, γ)	Slight

Note. The data in [1] were for the most part used in estimating the half-life of the radionuclides.

Figure 3 shows the most typical reactions and variations of radiation transformations of uranium and transuranium radionuclides in the products of atomic and thermonuclear explosions with a different composition of the nuclear fuel.

Figure 4 shows fragments of the spectra (obtained using a semiconductor gamma spectrometer) of gamma radiation from the large aerosol particles mentioned above, sampled along the tracks of the explosions of 1949 and

1953. In the spectra it is easy to discriminate the gamma lines of the following long-lived radionuclides: Cs-137, Co-60, Eu-152, Eu-154, Eu-155 and Am-241. Co-60 is an induced product, Eu-152 and Eu-154 belong to both groups—fission fragment and induced activity, Eu-155 belongs to the group of fission fragment products and Am-241 is accumulated as a result of the decay of Ru-141 (see Fig. 3). It must be noted that we determined Eu-152 and Eu-154 in aerosol particles as early as 1963.

Table 3. Activity of different radionuclides (and their ratios) in particles of explosions of 1949 (first four samples) and 1953 (last four samples) at measurement time (Bq/particle)

Sample number	Co-60	Cs-137	Eu-152	Eu-154	Eu-155	Am-241	Am-241/ Eu-152	Eu-154/ Eu-152	Cs-137/ Eu-152	Co-60/ Eu-152
49R1	2.18x10	1.27x10 ³	8.65x10	2.96	3.31x10	1.48x10	0.17	0.034	14.7	0.25
49R3	2.51	1.69x10	5.27x10	2.30	0.87	0.36	0.0068	0.044	0.32	0.048
49R8	3.01	4.02x10	5.07x10	1.79	2.02	1.12	0.022	0.035	0.79	0.059
49R10	7.74	2.69x10 ²	6.51x10	2.36	8.42	4.00	0.061	0.036	4.13	0.12
53R1	7.37	4.02x10 ²	5.05x10	4.86	2.06x10	1.72x10 ²	0.43	0.096	7.96	0.15
53R2	7.55	1.06x10 ³	5.99x10	4.63	2.66x10	1.48x10 ²	0.14	0.077	1.78	0.13
53R4	7.25	1.66x10 ²	5.52x10	4.83	1.29x10	9.90x10	0.60	0.088	3.01	0.13
53R6	9.41	7.05x10 ²	4.64x10	5.07	3.54x10	2.78x10 ²	5.99	0.11	15.2	0.20

With respect to the fission fragment radionuclide Eu-155 it must be said that for the time being it is to a considerable degree an "exotic" radionuclide—the literature gives the most different half-lives for it (from 1.7 to 4.7 years), but according to our preliminary data its half-life is more than 5 years. However, here doubt remains with respect to the contribution of the reaction Eu-154 (n,γ) Eu-155 to the effective yield of Eu-155 (especially in a thermonuclear explosion).

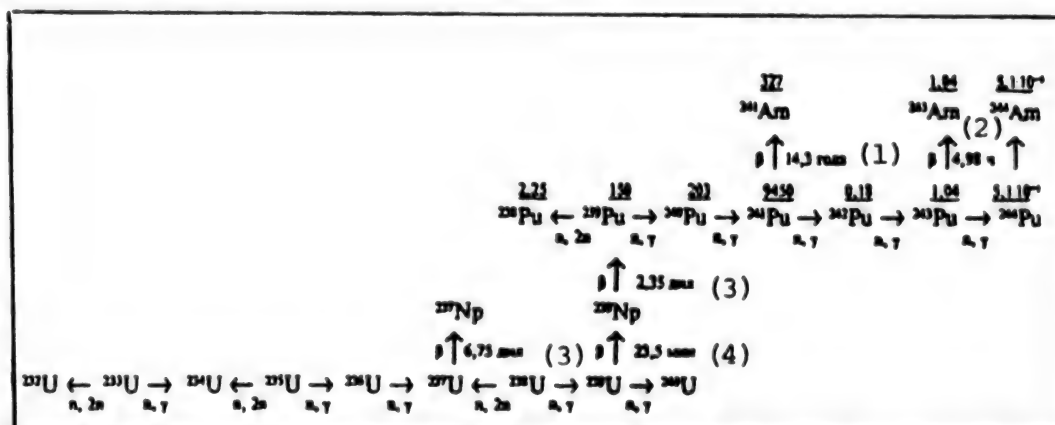


Fig. 3. Most typical reactions and variants of radiative transformations of uranium and transuranium radionuclides resulting in their registered quantities in products of nuclear and thermonuclear explosions with different composition of nuclear fuel. The underlined figures over the radionuclide symbols are the quantities in kCi injected into the atmosphere during explosion of IVY Mike (USA) on 31 October 1952 on Eniwetok atoll in Pacific Ocean [5].

Key: 1. years 2. hours 3. days 4. minutes

As we anticipated, Am-241 was discovered in the particles and its relative quantity was considerably greater in the particles of the 1953 explosion.

Table 4. Activity of different radionuclides and their ratios at time of measurement of samples (Bq/sample) in samples of fused slag at explosion epicenter

Number of sample	Co-60	Cs-137	Eu-152	Eu-154	Eu-155	Co-60/Eu-152	Eu-154/Eu-152
Explosion of 29 August 1949							
5	7.41x10 ⁵	1.84x10 ⁵	3.29x10 ⁵	4.72x10 ⁴	9.81x10 ⁵	2.25	0.14
Explosion of 12 August 1953							
1	9.63x10 ⁵	1.56x10 ⁵	6.88x10 ⁵	9.23x10 ⁴	4.76x10 ⁶	1.40	0.13
2	3.96x10 ⁵	4.50x10 ⁴	2.01x10 ⁵	3.21x10 ⁴	2.50x10 ⁶	1.97	0.16

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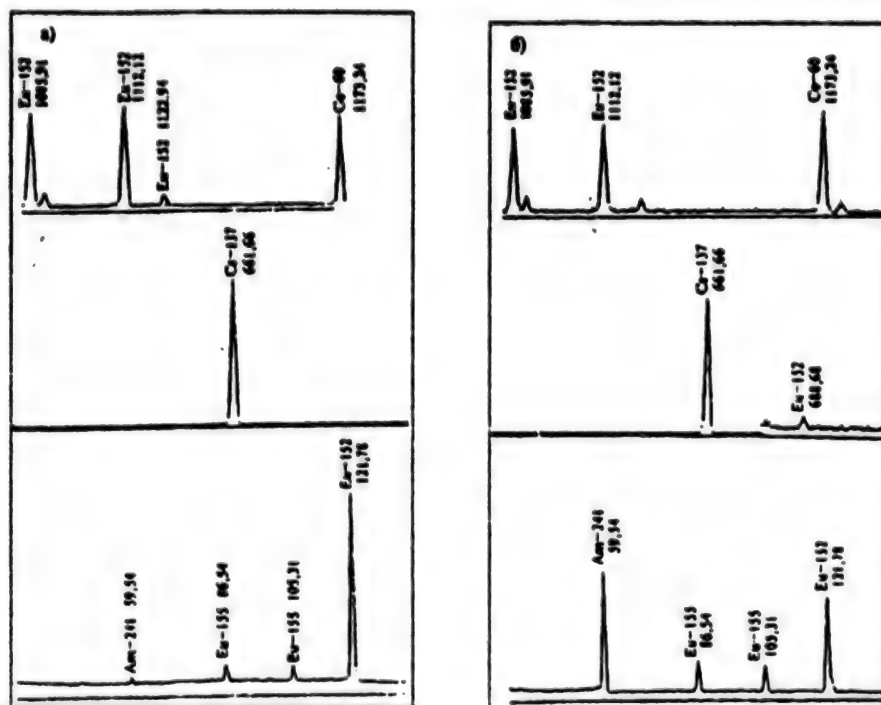


Fig. 4. Fragments of semiconductor gamma spectrum of aerosol particles from track of nuclear explosion of 29 August 1949 (a) and from track of thermonuclear explosion of 12 August 1953 (b) (measurements of 1994). The symbol for the radionuclide and the energy of the gamma radiation, keV, are plotted above each peak.

A careful study of the gamma spectra indicated that a number of lines in them still have not been identified, which suggests the possibility of supplementing the list of enumerated long-lived radionuclides.

Tables 3 and 4 give the results of measurements of the activity of different radionuclides in particles (Bq/

particle) and the "activity of detected isotopes/Eu 152 activity" ratios in particles and in fused slag in the explosion zone. There is only a small spread in the numerical values of the ratios in particles of the radionuclides Eu-154 and Co-60 and a great (but characteristic) spread for Cs-137 and Am-241 (relative to Eu-152).

Table 5. Results of measurements of contamination density (Ci/km² by different long-lived radionuclides along track of Chernobyl accident

Sample mass, kg	Cs-137	Cs-134	Sb-125	Eu-154	Am-241	Pu-238	Pu-239,-240	Sr-90
2.55	1.7	0.058	0.01	0.0034	0.028	0.0028	0.0028	0.076
2.83	1.5	0.051	0.016	<0.002	<0.002	<0.002	<0.002	0.22
2.59	1.24	0.041	0.019	0.0023	0.0023	0.0023	0.0031	0.062
1.85	1.16	0.039	0.011	0.0045	0.0022	0.0022	0.0028	0.11
2.17	1.88	0.064	0.21	0.0033	0.002	0.002	0.002	0.13
2.63	1.8	0.06	0.017	0.004	0.0024	0.0024	0.0032	0.096
2.73	1.18	0.037	0.01	0.0042	0.0025	0.0025	0.0025	0.067
3.01	1.64	0.063	0.013	0.0046	0.0037	0.028	0.0037	0.092
2.60	2.36	0.089	0.018	0.0032	0.0024	0.0024	0.0024	0.015

The determined ratios of radionuclide activities require further detailed analysis (with allowance for possible fractionation) and the collection of more statistics, but even now it is evident that the determination of long-lived isotopes in particles (or samples) from old tracks of nuclear

explosions is a realistic and extremely informative means for the identification of these tracks.

Some problems and difficulties associated with them arise: what about the soluble fraction of the radionuclide,

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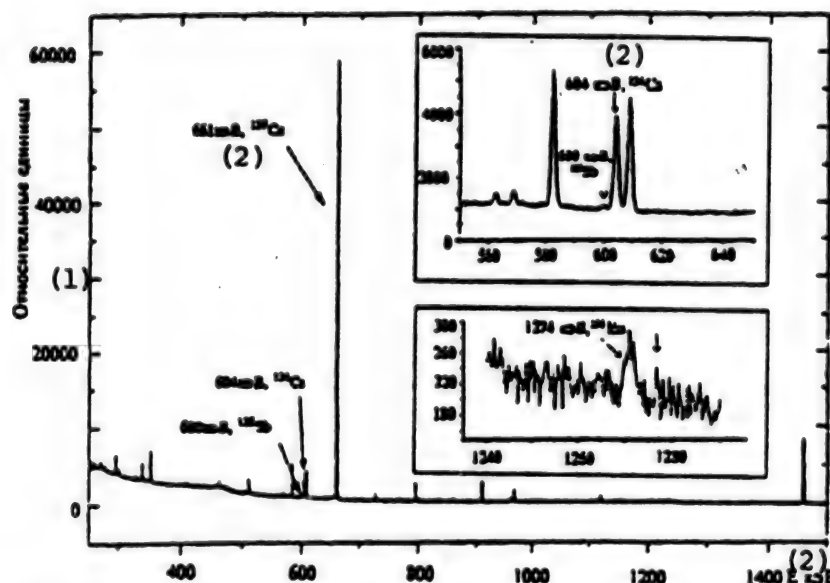


Fig. 5. Fragments of gamma spectra of radioactive sample (central Russia) from track of Chernobyl accident (measurements of 1994).

Key: 1. Relative units 2. keV

which over many years migrated separately from the particles (according to experimental data this is a relatively small part of the total activity of particles), but the taking and analysis of a full sample at a depth 0.5-1.0 m also may overcome these doubts.

With respect to the possibilities for measurement of long-lived radionuclides at great distances from a source, Table 5 and Fig. 5 give the results of measurements of different long-lived isotopes made at a distance of hundreds of kilometers from the site of the Chernobyl accident (although this was not a nuclear explosion, these data characterize the possibility of such measurements).

The taking of samples (and their analysis) along old tracks of nuclear explosions is now accomplished at great distances from the site of the explosion, including at the intersection of tracks, and will make it possible to confirm that the use of the described approach for the identification of individual nuclear explosions is realistic.

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Bibliography:

1. Zysin, Yu. A., Lbov, A. A. and Selchenkov, L. I., *Vykhody produktov deleniya i ikh raspredeleniye po massam. Spravochnik (Yields of Fission Products and Their Mass Distribution. Reference Book)*. Moscow, Gosatomizdat, 1963, 118 pages.
2. Basabikov, D. T., Loborev, V. M., et al., *Altay territory radioactive contamination levels and population effective dose exposure. Evaluation as a result of nuclear blasts at the Semipalatinsk test site*, in: *Proc. Intern. Symp. Remediation and Restoration of Radioactive-Contaminated Sites in Europe*, Antwerp, 11-15 October 1993, Vol 1, Doc. XI-5027/94, pp 403-420.
3. Edward H. and Fleming, Jr., *The fission product decay chains (Pu-239, with fission spectrum neutrons)*, Livermore, California. LRL. University California, 1967.
4. Izrael, Yu. A., Tsaturov, Yu. S., et al., *Reconstruction of the real pattern of terrain radioactive contamination from accidents and nuclear tests based on present-day and other data*, in: *Proc. Intern. Symp. "Remediation and Restoration of Radioactive-Contaminated Sites in Europe"*, Antwerp, 11-15 October 1993, Vol 1, Doc. XI-5027/94, pp. 325- 350.
5. Thomas, C. W. and Perkins, R. W., *Transuranium Elements in the Atmosphere*, HASL-291, New York, pp. 1-85-1-103, 1975.

Environmental Pollution and Radiation Conditions in Russia in September 1994

957A0278B Moscow METEOROLOGIYA I
GIDROLOGIYA in Russian No 12, Dec 94 (manuscript
received 25 Oct 94) pp 111-112

[Article by A. M. Ovanesyants, N. A. Belova and V. A. Savel'yev, Russian Federal Service for Hydrometeorology and Environmental Monitoring (Rosgidromet)¹; UDC 504.3.054"1994.09"(047)(47+57)]

[FBIS Translated Text]

Environmental pollution resulting from accidents

Atmospheric air. Five tank cars with solvent and paraxylene left the tracks in the neighborhood of Bezdovodka station in Ulyanovo Oblast on 22 September. After five days in the air at a distance 400-600 m from the accident site the hydrogen chloride content was 9-15 MAC (maximum admissible concentration). Soils.

On 14 September, in the neighborhood of Rassokha station in Irkutsk Oblast, a railroad accident occurred, as a result of which 17 tank cars with petroleum products left the rails. The polluted area was more than 15 thousand square meters.

Water bodies. During September 1994 no information was received on accidents resulting in extremely high pollution of water bodies (in September 1993 there were three accidents in three water bodies).

Extremely high environmental pollution

Atmospheric air. In September 1994 there were no cases of extremely high air pollution (exceeding the maximum one-time (mot) maximum admissible concentrations MAC_{mot} during a 20-minute observation period by a factor of 50 or more or mean diurnal (md) maximum admissible concentrations MAC_{md} by a factor of 30-49) (in September 1993 they also were not registered).

Water bodies. In September 1994 extremely high pollution (exceeding of the maximum admissible concentrations by a factor of 100 or more, sharp worsening of the organoleptic properties of water), accidents and cases of fish kills were registered in the territory of the Russian Federation 12 times in 9 water bodies (in September 1993—4 times in 3 water bodies).

In the Uk and Iska Rivers in Omsk Oblast there was a concentration of petroleum products with 103 and 195 MAC respectively. The pollution source was not ascertained.

As before, extremely high pollution was observed in the following rivers: Pelshma in Arkhangelsk Oblast (deficit of dissolved oxygen, organic substances relative to the BOD_5 —57 MAC and lignosulfonate—110 mg/liter), Neman and Pregola in Kaliningrad Oblast (presence of hydrogen sulfide up to 0.19 mg/liter), Neyva in Sverdlovsk

Oblast, Miass in Chelyabinsk Oblast (presence of hydrogen sulfide up to 0.19 mg/liter), Nyduyay in Murmansk Oblast (copper ions—102 MAC).

Forest industry and metallurgical enterprises and housing-communal facilities were responsible for the pollution.

High environmental pollution

Atmospheric air. Cases of high atmospheric pollution (HP) (exceeding the MAC_{mot} by a factor of 10 or more) by substances in the second hazard class were registered 16 times in 9 cities: with hydrogen chloride—up to 11 MAC at Omsk (5 cases), up to 18 MAC at Solikamsk (3 cases) and up to 15 MAC at Ulyanovsk; with nitrogen dioxide—up to 11 MAC at Shelkovo (2 cases) and up to 17 MAC at Nazarovo and Magnitogorsk; with hydrogen fluoride—10.3 MAC at Syzran; with hydrogen sulfide—10.1 MAC at Yakutsk; with phenol—13 MAC—at Lipetsk (in September 1993—15 times at 5 cities). In Omsk there also were 14 cases of high pollution with acetaldehyde (up to 26 MAC) and two cases with ethyl benzene (up to 10.5 MAC), at Chita—one case of high dust pollution (17 MAC) and at Norilsk—one case of high pollution by sulfur dioxide (14 MAC). During the course of September in the atmosphere of 11 cities the presence of pollutants in concentrations of 10 MAC or more was registered in 34 cases. (In September 1993—in 10 cities in 41 cases.)

Water bodies. In September 1994 in the area of the Russian Federation there were 161 cases of high pollution in 97 water bodies.

As before, the greatest pollution was registered in the following river basins:

—Ob and its tributaries the Irtysh and Tobol (more than 38% of all cases of HP) in the territory of Novosibirsk Oblast—with ammonium and nitrite nitrogen (10-15 MAC), Altay Kray—with mercury ions (2-5 MAC), Sverdlovsk, Chelyabinsk and Kurgan Oblasts—with copper ions (30-80 MAC), Sverdlovsk Oblast—with petroleum products (12-34 MAC);

—Volga and its tributaries the Oka and Kama (more than 17% of all cases of HP) in the areas of Ulyanovo, Ryazan, Vladimir, Tula and Moscow Oblasts—with nitrite nitrogen (10-15 MAC), Perm and Sverdlovsk Oblasts—with copper ions (30-86 MAC), with petroleum products (10-55 MAC) and with hexavalent chromium ions (10-15 MAC).

Moscow city. In September the mean monthly concentration of formaldehyde in the urban atmosphere was 4.3 MAC, benzene—4.2 MAC, nitrogen dioxide and ammonia—2.5 MAC and carbon monoxide and dust—1.3 MAC.

The maximum one-time concentrations on individual days of the month attained: nitrogen dioxide—4.9 MAC on Shipilovskaya Street, 4.6 MAC on Balchuga, 3.8 MAC in Sukharevskaya Square; ammonia—4.4 MAC on

Shipilovskaya Street; phenol—3.6 MAC on Turistskaya Street; carbon monoxide—2.4 MAC in Sukharevskaya Square; dust—2.4 MAC on Narodnoye Opolcheniye Street.

Lake Baykal. As before, the sewage of the Baykal Cellulose and Paper Combine was dumped into Lake Baykal in violation of the norms for its content of pollutants. For example, violations for chlorides were detected in 64% of the samples analyzed in September, for phenols—in 37% of the samples, for suspended matter and coloration—in 17% of the samples and with respect to poorly oxidizable organic substances (COD)—in 13% of the samples.

Radiation conditions

During September 1994 radiation conditions were stable in the territory of the Russian Federation. The concentrations of radioactive substances in atmospheric air, the densities of their fallout and the dose intensities of gamma radiation in the terrain in the territory of the Russian Federation beyond the limits of the contamination zones caused by the Chernobyl catastrophe and other radiation accidents fell within the range of variations of the natural background.

According to the results of regular intensity measurements of the exposure dose of gamma radiation in the terrain (TED) in the territories of 16 oblasts in the Russian Federation (Belgograd, Bryansk, Voronezh, Kaluga, Kursk, Leningrad, Lipetsk, Nizhegorod, Orlov, Penza, Ryazan, Saratov, Smolensk, Tambov, Tula, Ulyanovo), as well as the Mordovia and Tatarstan Republics, contaminated as a result of the Chernobyl NPP accident, no appreciable changes in radiation conditions were noted in comparison with the preceding months.

There were no changes in radiation conditions in the regions where the Kursk, Novovoronezh, Smolensk, Kalinin and Leningrad nuclear power plants (NPP) are located in comparison with the preceding month. The TED levels in the regions of 100-km NPP observation zones fell in the range from 7 to 17 $\mu\text{R}/\text{hour}$.

Footnote:

1. This is an official Rosgidromet report.

Possible Way to Devise a Standard System of Notations for Quantities Employed in Geodesy

957A0369A Moscow GEODEZIYA I KARTOGRAFIYA
in Russian No 12, Dec 94 pp 3-6

[Article by A. S. Trofimov and A. I. Spiridonov, UDC 528.2/.5:389.6]

[FBIS Translated Text] The selection of scientifically sound notations for the physical quantities used is an indispensable step in developing a standardized terminology. Attempts in this direction have been undertaken in the past [1-2].

The need for devising a standardized system of those notations used in geodesy has been dictated by the following considerations:

- a number of instructions and regulations on geodetic measurements and regulations are now being reexamined and therefore insofar as possible it would be appropriate to introduce into them unified (for example, in the form of a list) notations for quantities;
- in addition to officially confirming traditional notations, it is desirable to apply in practical work some general principles for devising notations, being guided by which geodesists in different organizations would be able to propose notations above and beyond the limits of some generally accepted list which would be convenient and understandable for everyone;
- the use of personal computers in preparing geodetic technical documents is making possible broad use of three types of alphabets: Cyrillic, Latin, Greek, as well as subscripts and superscripts (all the notations in this article were composed on a personal computer using an editor of the MASTER system), which, to be sure, facilitates the writing of documents in a modern style;
- the preparation of norm-setting documents on terminology in the fields of geodesy, phototopography and cartography has in general been completed, but their shortcoming is the absence of notations for the employed quantities.

When devising a system of notations the principal problem is working out a unified methodology for its construction. We feel that it is useful to apply the principles set forth below.

There must be a list of notations which includes a limited number of those quantities most commonly employed in work activity and in most cases having definitions in state or branch documents giving terms and definitions. This list would officially confirm the traditional notations, a change of which is undesirable for many reasons, and also symbols ensuring the devising of new notations and a limited number of notations formed in accordance with definite principles.

The principles for devising notations may be the following:

- insofar as possible, select one symbol for denoting the fundamental concept and accompany this symbol by subscripts or superscripts modifying this concept, such as r_h , r_v , etc.;
- assign a symbol a descriptive property or the property of an operator relative to the quantity which follows, for example, Δ denotes an increment, δ denotes the systematic error and a line at the bottom a mean value, etc.;
- the descriptors, operators, subscripts or superscripts cited in the list have an identical sense for all the symbols used with them; for example, the subscript

"e" is used with all elements related to an ellipsoid, the subscript "—" (underlining> always denotes a mean value, etc. (exceptions to this rule can be made only in cases when the symbols are used in completely different fields and their simultaneous appearance in the same document is improbable);

—a subscript or superscript is not mandatorily considered as coinciding in sense with the principal list symbol to which it is close in form of writing, that is each list subscript or superscript has its own significance (with a few possible exceptions, see preceding point);

—it is desirable that the notations for the most traditionally used quantities be retained.

The notations for the geodetic quantities defined in State Standard (GOST) 22268-76 "Geodesy. Terms and Definitions" and in RD BGYel 14-92 "Geodetic Measurements. Terms and Definitions" proposed by the authors are given below.

All these symbols take into account the possibility of their reproduction on a personal computer. The organization of an electronic variant of a reference list on a PC on the basis of this list will facilitate not only the choice of the appropriate notation, but also a method for its entry into a prepared document.

Term	Notation
Figure of the Earth	
Earth's gravity potential (gravity potential)	W
Earth's gravity perturbing potential (perturbing potential)	δW
Earth's gravity (acceleration of gravity)	g
Earth's normal gravity	g_0
Geopotential constant	C
Anomaly of Earth's gravity (gravity anomaly)	δg
Plumb line deflection	δ
Height of geoid	H_g
Radius of curvature of meridional section of Earth's ellipsoid	R_M
Radius of curvature of section of Earth's ellipsoid perpendicular to a meridian	R_N
Mean radius of curvature	R_{MN}
Radius of parallel	r
Semimajor axis of Earth's ellipsoid	a
Seminor axis of Earth's ellipsoid	b
Flattening of Earth's ellipsoid	α_e
Coordinate systems	
Astronomical zenith	Z
Astronomical azimuth	A
Astronomical latitude	φ
Astronomical longitude	λ
Geodetic zenith	Z_e
Geodetic azimuth	A_e
Geodetic latitude	B
Geodetic longitude	L
Geocentric rectangular coordinates	X, Y, Z
Astronomical zenith distance	z
Geodetic zenith distance	z_e
Horizontal angle	β
Vertical angle	u
Direction angle	α
Geodetic height	H_e
Normal height	H_n

Term	Notation
Coordinate systems (continued)	
Orthometric height	H_{or}
Dynamic height	H_d
Network construction	
Rectangular coordinates on plane	x, y
Convergence of meridians on plane	γ
Spherical excess of triangle	ϵ
Convergence of meridians on ellipsoid	γ_e
Correction for curvature of image of geodesic	ΔS
Azimuth of geodesic	AS
Absolute elevation of point	H
Relative elevation	h
Linear centering element	l_i
Angular centering element	θ_i
Linear reduction element	l_v
Angular reduction element	θ_v
Corrections to direction for centering and reduction respectively	$\Delta i, \Delta v$
Number of directions at point	k
Distance found after introducing instrument corrections and corrections for meteorological conditions	D_i
Distance (base length) between points of relativity of measurements (slant range)	D_r
Ground distance	D_H
Base length, reduced to sea level	D_0
Graduation of micrometer drum	μ
Length of tape, wire or rod at temperature t	l_t
Reading on horizontal or vertical circle with position of vertical circle to right	R
Reading on horizontal or vertical circle with position of vertical circle to left	L
Mathematical processing	
Nonclosure (function of measurement results)	w
Random component of error in measurements (measuring instruments) (is accompanied by a subscript denoting the quantity); random error	σ
Systematic component of error (is accompanied by a subscript denoting the quantity)	δ
Measurement result error	δ_{meas}
Error caused by external conditions	δ_e
Instrument error (instrument measurement error)	δ_i
Personal error	δ_g
Measurement method error (measuring device error)	δ_T
Reading error	δ_a
Sighting error	δ_v
Working measure error	δ_M
Error for reading system run	δ_r
Collimation error	δ_c
Cyclic error	δ_{cy}
Phase error	δ_{ph}

Term	Notation
Mathematical processing (continued)	
Correction or increment (is accompanied by subscript or line notation indicating a corrected quantity)	Δ
Mean arithmetic value of measured quantity	\bar{x} (underlined)
Deviation from arithmetic mean	v
Number of measurements made	n
Standard deviation of measurement result; empirical rms error; RMSE	m
Rms error of arithmetic mean	m_x
Rms error for difference of double measurements	m_d
Weight (of measurement result)	p
Inverse weight	Q
Rms error of measuring instrument; RMSE	m_i
Vertical circle null point	NP
Vertical circle zenith point	ZP
Run of horizontal circle reading system	η_h
Run of vertical circle reading system	η_v
Level graduation	τ
Adjusted value (superscript)	0
Adjustment correction (is accompanied by subscript or line notation indicating corrected parameter)	Δ^0
Topography	
Scale	I/M
Reverse azimuth	$<A$
Magnetic azimuth	A_m
Magnetic declination	δ_m
Eccentricity of alidade or circle	e_i
Measuring instrument conversion factor	K
Correction for Earth's curvature and refraction	Δf
Range finder constant	ΔD
Refraction coefficient	K_r
Figure area	P
Instrument horizon	H_i
Height of sighting point above point of relativity of measurements	h_v
Height of instrument sighting axis above point of relativity of measurements	h_i
Relief contour interval	h_H
Applied geodesy	
Planning datum	H_{pl}
Actual datum	H_{act}
Deviation from alinement	δ_q

The use of the proposed notations will be most effective when preparing documents on a personal computer; several variants of work with them are possible:

- scrutiny of all terms in alphabetical order;
- transfer of symbolic notations from the reference list into a prepared document;
- recovery of a term from a definite or subordinate word;
- output of the entire reference list or its parts to a printer for independent use.

However, these variants can be realized only with the availability of the text editor LEXICON, the Russian MASTER system or those like it, such as Chi Writer, Windows.

The list cited above is intended for use in geodetic subdivisions of Roskartografiya (Russian Cartographic Administration) and other organizations performing geodetic work. It is assumed that it can be used in preparing norm-setting - technical and report documents in the geodesy field. In the event of official approval by Roskartografiya this list or one similar to it could become obligatory for use in production subunits.

It must be noted that the graphic capabilities of even small personal computers make it possible without great difficulties to introduce special notations convenient in the finalization of technical reports or projects at enterprises. The pseudographic symbols which at present can be composed on any PC will make it possible to introduce, for example, such notations as: geodetic mark (centered perpendicular to line at bottom); center of geodetic point (centered perpendicular to line at top); center of mark (cross); orientation point (same as for geodetic mark but underlined); leveling mark (same as for center of geodetic point but overlined); Laplace point (*); geodetic base (=). However, this possibility requires additional development work and discussion by specialists.

Bibliography

1. Vizirov, Yu. V., Spiridonov, A. I. and Khrenov, L. S., Standardization of letter notations, *GEODEZIYA I KARTOGRAFIYA* (Geodesy and Cartography), No 3, pp 36-37, 1988.
2. VKS OST-6345. Osnovnyye oboznacheniya v vyshey geodezii, topografii, barometricheskom nivelirovanii, gravimetrii, kartografii (VKS OST-6345. Principal Notations in Higher Geodesy, Topography, Barometric Leveling, Gravimetry, Cartography).

General Overview of Geosatellite Technology

957A0369B Moscow *GEODEZIYA I KARTOGRAFIYA* in Russian No 12, Dec 94 pp 6-11

[Article by M. M. Mashimov, UDC 528:629.783]

[FBIS Translated Text] In the era of geosatellite technology the earth sciences (geosciences) are experiencing a second youth. The celebrated poetic phrase of F. I. Tyutchev: "Happy is he who visited our world at the moments of its birth," in my opinion can rightfully be applied to the geosciences, whose shining hour has come about due to geosatellite technology. During the last three decades they have been transformed from a European culture to a cosmic culture, a culture common to all mankind, a culture gradually mastering geosatellite technology. It is difficult to find that specific descriptive word which to a small degree could express the significance of this renaissance in the geosciences for world civilization. However, I make bold to assume that the era of geosatellite technology will be as prolonged in time as the Neolithic in ancient history, provided that a solution is found for the problem of the safety of modern civilization. Accordingly, in my communication the emphasis will be on matters related to the certification of the Earth for life and safety, whereas other problems related to the geosciences will be dealt with in a generalized way and in a popular aspect.

Geosatellite technology is used most of all in geodesy. Because of it geodesy has advanced to the forefront in the medium of the fundamental natural sciences related to macronature [2, 5]. There is a fundamental possibility for studying the Earth's physical geometry and near space in its spatial-temporal change. Position determination by observations of artificial satellites (GPS technology) is an outstanding achievement. It is a generally known fact that GPS technology is gradually replacing traditional methods for determining coordinates and line lengths [1, 2]. However, both in Russia and beyond its boundaries equally attractive ways to apply it in the geosciences for the time being remain beyond the attention of society.

The first of these is the possibility of using the GPS method for determining standard azimuths, horizontal and vertical angles in a topocentric plane coordinate system. It is well known that the GPS method is intended for a precise determination of increments in equatorial coordinates ($X = X_2 - X_1$, $Y = Y_2 - Y_1$, $Z = Z_2 - Z_1$ between GPS detectors 2 and 1. The geodetic azimuth a and the zenith distance z of point 2 relative to point 1 are expressed as follows [2, 5]:

$$\begin{aligned} a &= \arctg Y' / X'; \\ z &= \arccos Z' / D = \arccos Z' / S; \\ D &= \sqrt{X'^2 + Y'^2}; \quad S = \sqrt{X'^2 + Y'^2 + Z'^2}. \end{aligned} \quad (1)$$

In these formulas X' , Y' , Z' are the topocentric plane coordinates of point 2 relative to point 1

$$\begin{bmatrix} X' \\ Y' \\ Z' \end{bmatrix} = A' \begin{bmatrix} X_2 - X_1 \\ Y_2 - Y_1 \\ Z_2 - Z_1 \end{bmatrix},$$

where A' is a matrix transposed from the matrix A , whose elements are functions of geodetic latitude B_1 and longitude L_1 of point 1 [2, 5]. In this case

$$\begin{aligned} a_{11} &= -\sin B_1 \cos L_1; a_{12} = -\sin L_1; a_{13} = \cos B_1 \cos L_1; \\ a_{21} &= -\sin B_1 \sin L_1; a_{22} = \cos L_1; a_{23} = \cos B_1 \sin L_1; \\ a_{31} &= \cos B_1; a_{32} = 0; a_{33} = \sin B_1. \end{aligned}$$

With the high accuracy in GPS determinations [3] ($m_x = m_y = m_z = m = 0.005$ m) the geodetic azimuth and zenith distance, computed using formulas (1), can be adopted as standard values. In actuality, it follows from formulas (1) that $m_a = m/D$; $m_z = m/S$. With a distance between points $D = S = 10$ km we have $m_a = m_z = 0.1''$.

The astronomical azimuth α and the zenith distance z^0 will have the following respective errors

$$m_\alpha = \sqrt{m_a^2 + m_\lambda^2 \sin^2 B}; m_{z^0} = \sqrt{m_z^2 + m_\delta^2},$$

where m_λ , m_δ are the rms errors in determining astronomical longitude and plumb line deflection.

We will assume that $m_a = m_z = m_\lambda = m_\delta = 0.1''$; then we obtain the estimates $m_\alpha = 0.10 \dots 0.14''$, $m_{z^0} = 0.14''$. In this case the accuracy in computing a horizontal angle will be

$$m_\beta = m_\alpha \sqrt{2} = 0.14''.$$

It also is noteworthy that at geodetic points with known astronomical coordinates there no longer is a need for observations of astronomical azimuth. This means that the principal object of geodetic astronomy is becoming precise determinations of latitudes and longitudes. When constructing precise spatial geodetic networks it is necessary to have a dense network of astrogeodetic points. At the same time a Laplace point in its traditional representation is excluded from the makeup of the new AGN (Astrogeodetic Network).

Thus, by jointly using data from traditional astrogeodetic and GPS determinations it is possible with a high accuracy to ascertain the azimuths and the horizontal and vertical angles necessary for the metrology of the methods and instruments used in angle measurements in astrogeodesy and for tracing crustal deformations in geodynamic test ranges.

The conclusion that it is possible to have selective certification of horizontal angles (both measured and adjusted) in

the SGN by the GPS method follows as being self-evident. To be sure, in this case there is even no need for data on plumb line deflections because the differences in relative elevation between SGN points differ so insignificantly that it is possible to solve the problem of certification of angles as a two-dimensional geometric problem. Probably only in this way will it be possible to estimate the systematic distortions of angles in those places where observations were made by circle procedures from trihedral signals using theodolites not outfitted with check telescopes or to ascertain the quality of joint adjustment of first- and second-order triangulation, a catalogue of whose points will be compiled in the next few years.

It is known that adjustment of the geodetic network provides the anticipated result only in a case when it represents uniform statistics, that is, is reduced to a single epoch and is free of error in initial data and systematic measurement distortions [2]. The first- and second-order State Geodetic Network, consisting of 350 thousand points, was established over the course of 70 years [1]. Accordingly, it naturally does not provide uniform statistics and the problem of its certification after adjustment is one of the urgent tasks of geodesy.

In my opinion there is a second approach in application of the GPS method which is less evident. This is the possibility of determining relative leveling differences with an accuracy equal to the accuracy in precise leveling and in study of the local geoid.

I note that by having anomalies of heights ζ determined by astrogeodetic (astrogravimetric) leveling (AGL) and geodetic heights H as GPS technology data it will be possible to compute the relative leveling differences $\Delta h = h_2 - h_1$ with an accuracy corresponding to the accuracy in precision leveling using the formula

$$(h_2 - h_1) = (H_2 - H_1) - (\zeta_2 - \zeta_1). \quad (2)$$

The first term on the right-hand side of (2) can be determined by the GPS method at the accuracy level of first-order leveling. The problem is reduced to an evaluation of the second term on the right-hand side of (2) and essentially involves determining the gravity potential anomaly $T = (h + \zeta)\gamma_m - [\text{integration sign}] gdh$ with the required accuracy and reconciling the derivations of the anomaly of heights ζ and plumb line deflections δ ensuring an evaluation of the left-hand side of (2) at the accuracy level of second-order leveling. As the inverse potential problem it is multidimensional and the most complex in the class of problems in theoretical geodesy [2, 5]. In actuality differential equations in the form

$$\left(\frac{\partial T}{\partial X'}\right)^2 + \left(\frac{\partial T}{\partial Y'}\right)^2 - (g\delta)^2 = 0; \quad (3)$$

$$d\zeta + \delta ds + \frac{g-\gamma}{\gamma_m} dh = 0, \quad (4)$$

apply and these must be solved jointly with equations taking into account nonstationarity of the Earth's figure and gravity field.

It is superfluous to explain that the determination of relative leveling differences at the accuracy level of third- and fourth-order leveling is not such a complex problem [4], particularly in regions where excesses of the geoid can be determined by application of the traditional AGL method [2, 5, 6].

The one-dimensional geodetic problem is an evaluation of the excess of the geoid ($\Delta\zeta = \zeta_2 - \zeta_1$, on the basis of formula (2) with known leveling ($\Delta h = h_2 - h_1$) and GPS ($\Delta H = H_2 - H_1$) excesses. For example, when $m_{\Delta h} = m_{\Delta H} = 0.01$ m we have $m_{\Delta\zeta} = 0.014$ m. GPS technology therefore is providing a new method for studying the geoid, but at the same time as an alternative to geometric leveling it is stimulating the development of new approaches in study of the geoid [2-6]. To be sure, reference is to methods making it possible to ascertain inclination of the geoid with an accuracy 0.01 m with allowance for its temporal changes in regions of development of high technologies and in megapolises, where nuclear power plants and other engineering structures particularly dangerous in their operation are being constructed, as well as in geodynamic test ranges intended for prediction of the place and time of strong earthquakes.

The broadened use of GPS technology in geodesy requires the further development of geodetic astronomy. Unfortunately, the scientific traditions of Russian astrometry are gradually being lost. The Pulkovo Astronomical Observatory, at the end of the 19th century generally recognized as the astronomical capital of the world, has become an ordinary observatory. And, indeed, other observatories of the CIS countries do not have a continuous series of data on the position of the pertinent zenith, that is, these observatories have ceased observations of the temporal changes in inclination of the geoid and their research is now of little value for geodesy and geodynamics. In addition, it is impossible to make a precise retrospective estimate of both the annual and secular parameters of the Earth's rotation (coordinates of the pole and angular velocity of rotation) due to the absence of continuous statistics on the positions of the zeniths of astronomical observatories [2]. The use of GPS technology in the earth sciences requires a return of astronomical observatories in our country to their roots. In other words, each observatory must first of all have a continuous series of data on the position of its own zenith. The astronomical observatories of the CIS countries, which must be included in the fundamental astrogeodetic network, will satisfy this requirement. The astrogeodetic and gravimetric surveys carried out in Russia under new programs as the 20th century passes into the 21st century will play a role of more than a little importance in studying the geoid [2-4].

Astrogeodetic, gravimetric and geophysical support of study of movements of the crust and lithospheric plates,

changes in the levels of seas and the world ocean, prediction of earthquakes and volcanic eruptions, major catastrophes of a natural or anthropogenic character and monitoring of the natural and technogenic medium in response to individual requests is becoming realistic with the use of geosatellite technology in combination with the traditional methods of astrogeodesy and geophysics. The networks of astrogeodetic, gravimetric and geophysical points in geodynamic test ranges will be constant reference points for study of the Earth's dynamics, provided that their coordinates are periodically determined by space geodesy methods.

However, the objective of practical geodesy in the next few years, I feel, will be the application of GPS technology for commercial certification of maps of geoid heights for urbanized areas, regions of intensive production of oil and gas and seismically active regions; such regions include the Turan Depression, Caucasus, Baykal region, Pacific Ocean coast, Sea of Okhotsk, Kamchatka, Sakhalin and Kuril Islands. Since the initial astrogeodetic and gravimetric data have a high value, their commercial certification under market economy conditions must be an attribute of the economy of geodetic production work. It is superfluous to explain that geodetic marketing will not be viable without the presence of a corresponding certificate attesting to the quality of the initial astrogeodetic and gravimetric data.

The third direction in use of GPS technology is calibration of variometer and gravi-inertial measurements, which will play a key role in astrogeodetic work at the beginning of the third millennium [2]. For surface inertial geodesy this will require standard data on anomalous heights and plumb line deflections, relative elevations and azimuths, and for variometry this will require a dense network of points at which plumb line deflections are stipulated. All this is in addition to the fact that the GPS method provides a coordinate reference system for permanent calibration of variometers and tools for surface inertial geodesy in a real time mode.

The noteworthy properties of GPS technology noted by me earlier in [2, 3, 5] and in this article are actualizing its large-scale application in geodesy. As the latest technology it is exerting an influence on methods and schemes for constructing reference geodetic networks and formulation of work in the fields of astronomy, gravimetry, geodynamics and precise leveling in Russia and in other countries of the world community.

The construction of astrogeodetic networks for a new purpose is the fourth direction in use of geosatellite technology [1-3, 5]. Geosatellite technology will make it possible to have qualitatively new astrogeodetic networks. According to the new Fundamental Regulations on the State Geodetic Network (SGN), plans call for establishing fundamental and highly accurate astrogeodetic networks which will be characterized by relative errors in determining sides of 1×10^{-8} and 1×10^{-7} with their mean lengths 1000 and 150-300 km respectively.

The maintenance of the existing first- to fourth-order SGN at the level of present-day problems and its modernization in case of necessity will be accomplished primarily with the use of GPS technology. Only 9 thousand of 350 thousand points will be in active use and the others will become an object of periodic inspection as a permanent nondecreasing reserve reflecting the real status of the SGN in the territory of the CIS countries [1].

One of the noteworthy properties of GPS technology is the possibility of making observations from tripods, precluding a labor-intensive and material-wasteful form of work—the construction of signals.

Natural geography is the fifth field of application of geosatellite technology. Topographic and cadastral surveys, monitoring of the Earth and circumterrestrial space, study, use and conservation of natural resources, ecology and prevention of catastrophes of a natural and technogenic character—these are those principal directions in the geographic application of geosatellite technology developing within the framework of conversion programs not less intensively and successfully than in the fields of geodesy and geophysics. The above-mentioned aspects of geographic application of geosatellite technology, as in the fields of geodesy and geophysics, have a global, international character. It is understandable that geographic materials, jointly with data from geodesy, geophysics and the other earth sciences, must constitute a general geoinformation space in a unified coordinate reference system. Along these lines I note that the existence in Russia of various geodetic reference coordinate systems is an anachronism inherited from an epoch when geoinformation space was divided into individual parts among departmental monopolists for the purpose of ensuring operational secrets. However, in Russia, where use is now being made of CS-90 (global) and WGS-84 (world) geodetic systems when observing the GLONASS and NAVSTAR satellite space navigation systems, the CS-42 reference system when using geodetic catalogues and topographic maps and local systems when representing cadastral survey and thematic mapping materials, the difficulties are growing enormously with broadening of the use of geoinformation-based technologies. It is evident that the tasks of coordinate-time support of new geoinformation technologies, navigation and on-line position determination in all geospheres and in circumterrestrial space can be solved successfully in a unified planetary geocentric geodetic coordinate system (PGGCS). However, the situation in Russia with use of geodetic coordinate systems is not improving. GPS technology, based on observations of the NAVSTAR navigation satellite in the world system WGS-84, is no longer effective. Accordingly, permit me to repeat my opinions expressed 6 years ago in [4]:

"The use of data on geophysical fields (gravity, magnetic and thermal) and topography of the Earth's solid shell and the world ocean in leading branches of science and technology, where the priority direction is the development of information technologies, is becoming a matter

of everyday practice. It also is desirable that digital banks of geophysical fields used for the functioning of discrete automatic systems, for digital maps and terrain models for great expanses, also be set up using the PGGCS.

"Coordinate systems in geodesy and in the other earth sciences have continental, planetary and space applications. This for the time being is not being recognized by the organizations which are engaged in the plotting of digital maps and terrain models in the coordinate system of 1942.

"A changeover to a unified PGGCS in work in our country is one of the urgent tasks in practical geodesy. Its solution will require expenditures for recomputing geodetic catalogues and conversion of accumulated digital banks of geodetic and cartographic information from the coordinate system of 1942 into the PGGCS. A great amount of work must be done in applying the new geodetic coordinate grid on published topographic and special maps. It is evident that expenditures on a changeover to a unified PGGCS will increase with each year of delay in cessation of use of the coordinate system of 1942. Accordingly, the first step, in our opinion, should be a government decree on the introduction of a unified PGGCS for all geodetic, topographic and cartographic work for national purposes. The second step, for which a long time will be required, will be the gradual conversion of the geodetic, topographic and cartographic information accumulated up to the time of introduction of the PGGCS into the new geodetic coordinate system."

New high technologies based on the computer and electronic processing of geoinformation are stimulating organization of international, national and regional geonomic information centers. An International Geonomic Information Center (IGIC) will possibly have the following sections [5]: 1) geodesy; 2) topography of Earth's solid shell, seas and world ocean, planets and their satellites; 3) natural geography; 4) landscape shell and natural resources; 5) geology; 6) geophysics; 7) geochemistry; 8) lithosphere; 9) hydrosphere; 10) atmosphere; 11) magnetosphere; 12) natural and artificial space bodies; 13) astrometric, geodetic and physical parameters, construction of physical fields of the Earth, planets and their satellites; 14) dynamics of the Earth, planets and their satellites; 15) reference systems for inertial, planetodetic and planetographic coordinates, time and frequency standards; 16) devices and methods for storage, systematization, processing and management of geonomic information; 17) description of each type of geonomic information.

A State Geonomic Information Center (Gostsentr geomomii) will be a national affiliate of the IGIC and the Regional Geonomic Information Centers (RGIC) will be divisions of the Gostsentr geomomii. The organization of geonomic information centers at different levels will ensure the development of the latest technologies for all branches of human cultural activity. Geoinformation

systems (GIS) will be based on the totality of geonomic information, including digital and electronic maps, materials from cadastral surveys and monitoring of the natural and anthropogenic medium. In such a broadened understanding of GIS State and Regional Ecologic GIS (SEGIS and REGIS) can be visualized as branches of the Gosstentr geonomii and RGIC respectively [7].

This article on a general overview of geosatellite technology has the objective of arousing broad interest in this new high technology in the development of human culture in the earth sciences field and in study of circumterrestrial space. Naturally, geodetic, geophysical and geographic aspects of use of geosatellite technology are being considered in interrelationship to one another in a singular aspect, but its social impacts are being considered only fragmentarily at the level of discussion of the problems involved in its development as the 20th century passes into the 21st century.

Bibliography

1. Makarenko, L., Modern tasks in geodesy and topography, *GEODEZIYA I KARTOGRAFIYA* (Geodesy and Cartography), No 3, pp 23-24, 1994.
2. Mashimov, M. M., *Vyshaya geodeziya* (Higher Geodesy), Moscow, Izd. VIA, 1991, 552 pages.
3. Mashimov, M. M., Astrogeodetic network at the beginning of the third millennium, *GEODEZIYA I KARTOGRAFIYA*, No 3, pp 25-28, 1994.
4. Mashimov, M. M., Coordinate systems and geophysical fields in geodesy, *GEODEZIYA I KARTOGRAFIYA*, No 10, pp 8-12, 1988.
5. Mashimov, O. M., *Planetarnyye teorii geodezii* (Planetary Theories of Geodesy), Moscow, Nedra, 1982, 262 pages.
6. Ostach, O. M., Astrogeodetic leveling, *GEODEZIYA I KARTOGRAFIYA*, No 3, pp 28-33, 1994.
7. Ryzhov, V. F., Device for seeking underground communication lines based on geoinformation technologies, *GEODEZIYA I KARTOGRAFIYA*, No 3, pp 52-56, 1994.

Atmospheric Corrosion Tests of Metals Along Russian-Norwegian Boundary

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[Article by J. F. Henriksen, Norwegian Institute of Air Research, A. A. Mikhaylov and Yu. N. Mikhaylovskiy, Physical Chemistry Institute, Russian Academy of Sciences; the first paragraph is an abstract; UDC 620.193.21]

[FBIS Translated Text] The first year of atmospheric corrosion tests carried out by the Norwegian Institute of

Air Research and the Physical Chemistry Institute of the Russian Academy of Sciences in regions along the joint boundary of the countries where sulfur dioxide levels are high has been completed. The results, discussed here, confirm that in a subarctic climate, like in any other, atmospheric corrosiveness to a high degree is determined by the emission of pollutants of an anthropogenic origin. An equation is derived relating the rate of steel corrosion to the sulfur dioxide level and the surface moistening time. The importance of determining the real moistening time in the subarctic, where periods with a near-zero temperature are frequent and prolonged, is demonstrated. An atmospheric corrosion model is constructed which takes into account the SO_2 level which when exceeded results in an increase in the rate of metal corrosion.

The Nikel region in Murmansk Oblast is characterized by high sulfur dioxide levels. In accordance with a bilateral agreement between Norway and the Russian Federation on cooperation in the environmental protection field atmospheric monitoring posts were established along the joint boundary in the territories of the two countries and the aftereffects of the impact of sulfur dioxide on forests, natural vegetation and aqueous ecosystems are being studied.

Since 1988 the Norwegian Institute of Air Research (NIAR) has carried out atmospheric corrosion tests of materials at atmospheric monitoring sites in the territory of Norway and since 1990, jointly with the Physical Chemistry Institute of the Russian Academy of Sciences (PCI RAS), such tests are being carried out in the territories of the two countries. This communication gives the results of the first year of the tests, presented in the form of a report to the Norwegian Environment Ministry and the RF Ministry of Environmental Protection and Natural Resources [1].

Description of Program

The purpose of the program is a quantitative estimate of the impact of atmospheric sulfur impurities on the corrosion of metals in a subarctic climate.

Test sites: in Norwegian territory: Noatun, Kobbefoss, Senvik, Karpdalen and Viksofjell; in the territory of the Russian Federation—sites near the boundary represented on the map of the test region as S1, S2 and S3 (Fig. 1). A list of the studies made is schematically presented for all the sites in Fig. 1.

The tests have been made using flat samples measuring 100 x 150 mm, as well as spiral samples with a diameter of the turns 30 mm and a spiral length 90 mm made from wire 3 mm in diameter in accordance with the international standard ISO 9226 [2]. The flat samples were positioned at an angle 45° to the horizon on stands oriented in a north-south direction. The spiral samples were positioned vertically on a special horizontal panel attached to the stand at a distance 50 mm from one another [2].

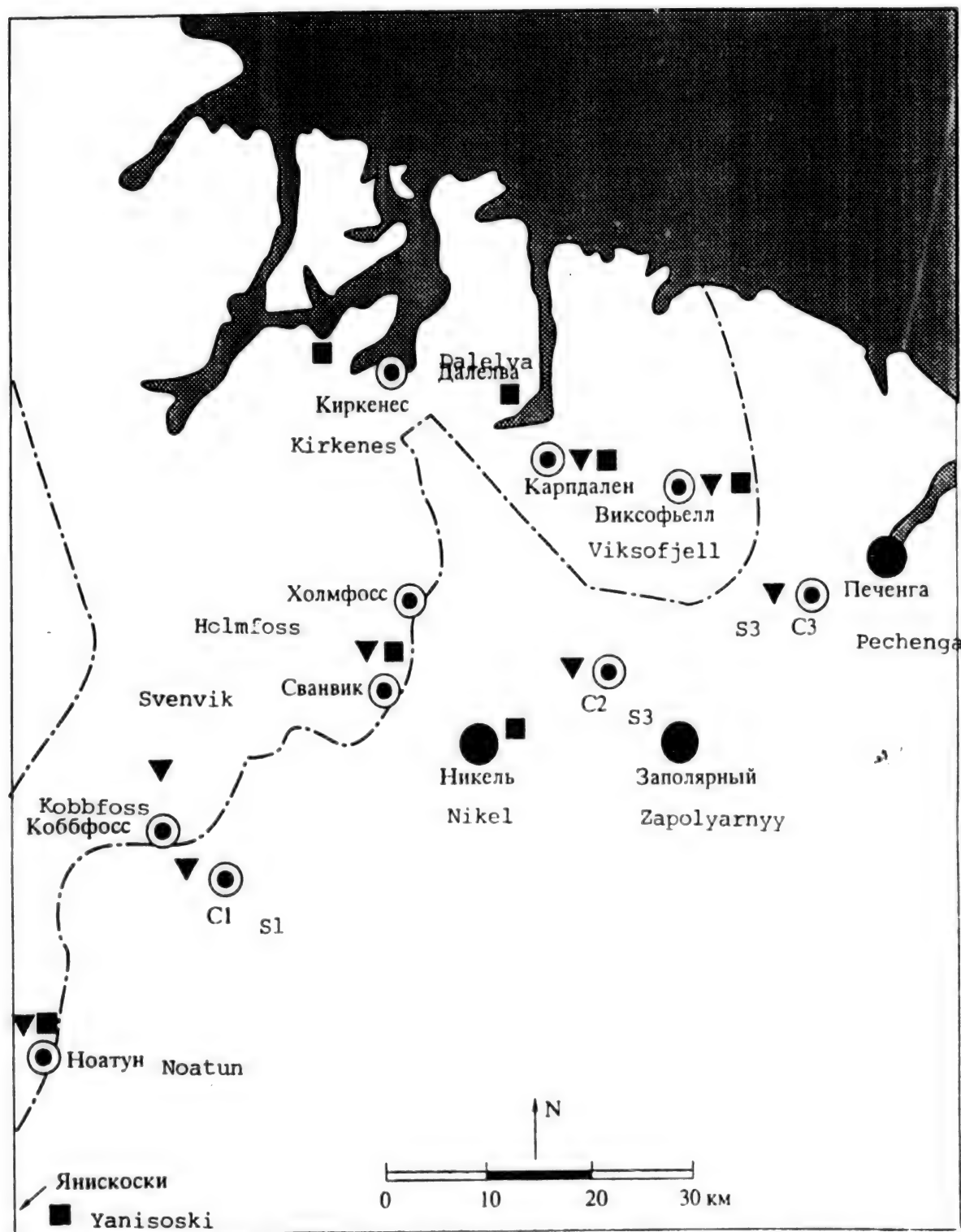


Fig. 1. Map of location of test sites and types of measurements made there. Notations: circle with dot at center—air quality; filled squares—meteorology; inverted filled triangles—corrosion.

The following were used as materials for the flat samples: carbon steel (Swedish standard SIS 141316 [3]), zinc (International Standard ISO 9226), steel with galvanic zinc plating (275 g/m² of zinc), steel with an "Alyutsink" plating (185 g/m² of chromed "Alyutsink").

The materials used for the spiral samples were: aluminum (International Standard ISO 9226), steel with galvanic zinc plating with a thickness 30 μ m, steel with a "Galfan" plating (95 percent zinc and 5 percent aluminum, 230 g/m²).

The duration of the tests of the flat steel samples was 1 month (12 exposures per year), 3 months (4 exposures per year) and 1 year. The remaining materials were tested throughout the year.

The tests were carried out during the period from June 1990 through May 1991. All the monitoring posts were outfitted with standard continuous-action automatic gas analyzers for sulfur dioxide registering the mean and the maximum (in 1 hour) SO₂ concentrations.

The rate of the dry fallout of aerosols (chlorine and magnesium) was registered each month at Svenvik, Karpdalen and Viksofjell using special traps developed at the NIAR in which paper filters were exposed [4].

The preparation of the samples for tests, determination of corrosion losses after tests, as well as analyses of the filters took place under the very same laboratory conditions at the NIAR.

Theoretical Premises for Analysis of Results and Construction of Atmospheric Corrosion Model

The kinetics of metal corrosion in an atmosphere containing sulfur dioxide at low concentrations can be represented schematically by curve 2 in Fig. 2 (curve 1 for a pure atmosphere) or in differential form as a change in the corrosion rate with time (Fig. 3) with three characteristic phases.

Phase I. In this initial phase the metal surface is covered by an air-oxide film and is still contaminated insignificantly. The corrosion rate is low. With the accumulation of sulfurous pollutants in the surface film of the electrolyte the air-oxide film begins to be destroyed and the corrosion rate increases (transition region from sector I to sector II), Figs. 2, 3.

Phase II. Metal destruction occurs at a limiting virtually constant rate.

Phase III. The layer of corrosion products forming on the surface begins to screen the metal and retard corrosion. Its rate begins to decrease.

The duration of phase I is dependent on atmospheric pollution. The accumulation of pollutants on the surface

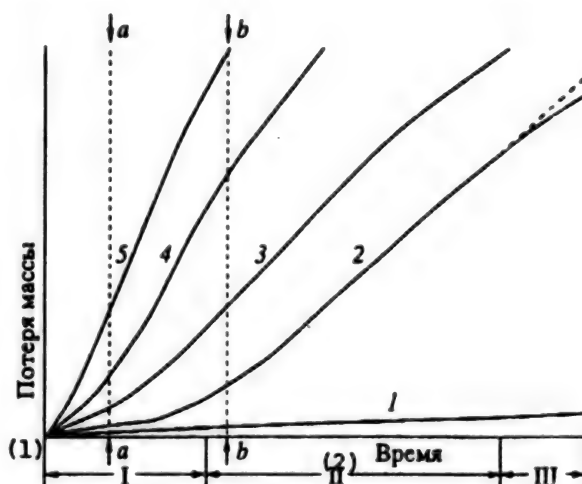


Fig. 2. Kinetics of development of atmospheric corrosion of metal with different sulfur dioxide levels. (C_{SO_2})₁ = 0; $S_5 > S_4 > S_3 > S_2$.

Key: 1. Mass losses 2. Time

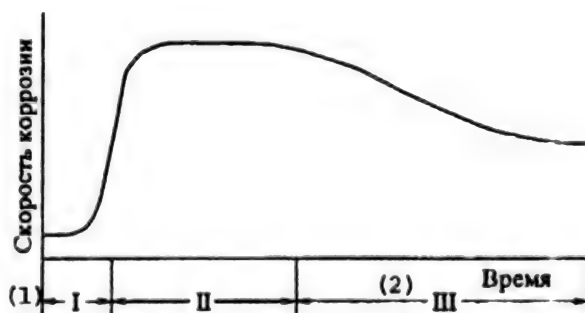


Fig. 3. Kinetic curve of rate of atmospheric corrosion of metal.

Key: 1. Corrosion rate 2. Time

occurs the more rapidly the higher the sulfur dioxide concentration (in Fig. 2 $S_5 > S_4 > S_3 > S_2$). During the course of phases I and II the corrosion rate increases and their duration decreases. In a limiting case with the S_5 pollution level the duration of phase I becomes virtually zero.

The relation between the different phases also is different. A time-constant corrosion rate for some metals can be observed over the course of several years (sector II).

Using the curves in Fig. 2 it is possible to construct the dependence of metal corrosion on the sulfur dioxide concentration. In Fig. 4 this is shown for two sections for the moments in time (a) and (b). On the mass losses axis a determination is made of the values corresponding to a given corrosion time in a pure atmosphere and on the SO₂ concentration axis a determination is made of the threshold of air pollution by sulfur dioxide from which intensive metal corrosion begins.

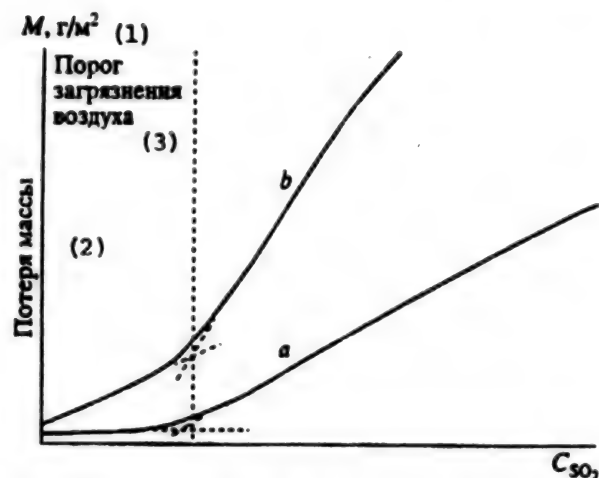


Fig. 4. Dependence of atmospheric corrosion of metal on atmospheric sulfur dioxide concentration.

Key: 1. $M, g/m^2$ 2. Mass losses 3. Air pollution threshold

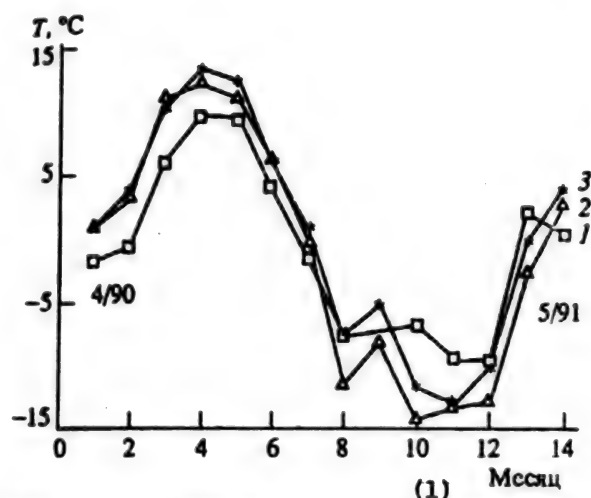


Fig. 5. Mean monthly air temperatures at Viksofjell (1), Svenvik (2) and Noatun (3). April 1990-May 1991.

Key 1. Month

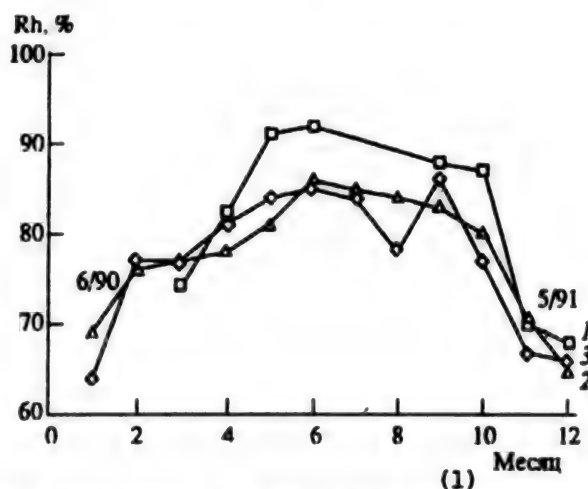


Fig. 6. Mean monthly relative humidities at Viksofjell (1), Svenvik (2) and Noatun (3). June 1990-May 1991.

Key: 1. Month

However, under real conditions the construction of a full curve of type a, Fig. 4, is complex. Other corrosive impurities, random combinations of the sulfur dioxide level and moistening time and brief sulfur dioxide bursts in background regions may distort the position of the pollution threshold. A lessening of the sulfur dioxide level in the course of exposure below the threshold level may result in partial or total passivation of some metals

(formation of an adsorption or phase protective film), which also will exert an influence on the kinetics of corrosion.

It is evident that the equation describing the real losses of metal mass as a function of the sulfur dioxide level need not mandatorily be linear. A linear approximation is possible only for individual segments of curves a and b, Fig. 4.

Experimental Results and Their Discussion**1. Environmental Data**

Temperature and relative humidity were registered at Viksofjell, Svenvik and Noatun. In general, temperature, relative humidity and the course of their change during the year are close at these stations and at Noatun and Svenvik they virtually coincide (Figs. 5, 6). Negative

temperatures were observed for six-seven months. During the autumn-winter period (from October) the maximum of the registered air temperatures drops sharply and in some cases does not exceed 0°C.

The mean monthly relative humidity is minimum in May-June (64-69 percent) and from April through August holds below 80 percent. During autumn-winter it increases by 15-20 percent and attains 85-92 percent.

Table 1. Duration of occurrence (hours/month) of relative humidity greater than 80 percent with air temperature 0, -2, -4 and -6°C

Test period (month/year)	Viksofjell				Svenvik			
	0	-2	-4	-6	0	-2	-4	-6
6/90	-	-	-	-	266	268	268	268
7/90	-	-	-	-	394	394	394	394
8/90	306	306	306	306	386	389	389	389
9/90	423	454	454	454	335	381	391	391
10/90	145	353	515	589	188	312	393	423
11/90	5	50	137	190	0	29	81	112
12/90	-	-	-	-	1	12	97	127
1/91	-	-	-	-	1	11	21	26
2/91	0	19	62	108	0	15	46	69
3/91	0	18	47	81	0	0	3	30
4/91	107	135	162	183	51	134	162	221
5/91	43	66	88	93	130	156	172	198

Table 2. Mean sulfur dioxide level (numerator) and its mean diurnal maximum (denominator), g/m³, at test sites monthly from June 1990 through May 1991

Month/year	Viksofjell	Svenvik	Noatun	Karpdalen	Kobbfoss	S1	S2	S3
6/90	12/63	12/68	7/61	5/41	14/122	13/83	18/116	9/60
7/90	11/68	12/106	7/51	7/48	4/40	9/81	11/91	7/27
8/90	38/123	11/68	3/14	25/133	5/63	4/17	51/161	16/90
9/90	37/188	9/96	4/35	22/108	5/41	4/35	53/220	26/167
10/90	25/122	5/38	2/19	21/119	-/-	3/19	58/348	32/152
11/90	26/186	11/125	2/23	12/75	-/-	15/96	57/418	65/267
12/90	47/231	11/84	14/149	27/115	-/-	14/57	-/-	65/239
1/91	66/406	18/92	11/58	44/293	-/-	12/52	-/-	45/190
2/91	49/526	11/98	7/48	20/160	-/-	11/56	118/612	85/292
3/91	82/570	40/608	9/46	45/356	-/-	20/157	124/571	89/304
4/91	39/128	8/144	2/19	19/114	-/-	8/77	67/320	65/466
5/91	13/50	8/50	3/20	8/74	-/-	6/37	12/85	13/85

Table 3. Dry fallout of aerosols, g/(m² day), monthly from June 1990 through April 1991

Month/year	Viksofjell			Karpdalen			Svenvik		
	Cl	Mg	Cl/Mg	Cl	Mg	Cl/Mg	Cl	Mg	Cl/Mg
6/90	1457.8	84.4	17.3	704.8	23.8	29.6	874.7	26.7	32.8
7/90	229.2	16.7	13.7	1944.1	64.5	30.1	830.2	20.2	41.1
8/90	1328.7	156.3	8.5	1333.3	116.1	11.5	774.2	47.3	16.4
9/90	735.5	34.4	21.3	1004.4	35.6	28.3	1026.7	53.3	19.3
10/90	1519.2	80.8	18.8	1273.1	81.7	15.6	907.5	43.0	21.1
11/90	5585.7	328.6	17.0	1435.6	71.1	21.2	693.3	26.7	26.0
12/90	7754.2	454.2	17.1	1458.1	55.9	26.1	888.9	24.2	37.0
1/91	5933.3	328.9	18.0	1412.1	90.9	15.5	777.0	41.4	18.8
2/91	3373.1	145.1	23.2	1171.4	54.4	21.5	915.6	43.5	21.0
3/91	4477.4	197.9	22.6	1281.7	73.1	17.5	434.4	17.2	25.6
4/91	1808.9	57.8	31.3	1142.2	40.0	28.6	351.1	-	-

The moistening time (τ), in accordance with the International Standard ISO 9223 [5] (that is, the time of combination of a temperature $T > 0^\circ\text{C}$ and a relative humidity $R_h > 80$ percent), was determined at Viksofjell and Svenvik. The corresponding monthly values at these sites differ insignificantly (Table 1). During the period from November through March the moistening times determined in this way are close to or equal to zero, which according to the traditional definition of moistening time should give evidence of virtual cessation of the atmospheric corrosion of metals during this period.

The time τ of existence of a temperature above -2 , -4 and -6°C also was determined for a statistical evaluation of the results.

In accordance with the geographic location of the test sites the τ values obtained at Viksofjell were applied in the computations to Karpdalen and test site S3, whereas the τ value for Svenvik was applied to Noatun, Kobbfoss and sites S1 and S3. During August-September 1990 the τ value for Svenvik was applied to all the test sites.

The sulfur dioxide levels at the test sites were dependent on wind speed and direction, intensity of the effluent and their remoteness from the sources (for the most part Nikel and Zapolyarnyy [6]) and varied in a wide range. This can be seen clearly from the mean monthly levels and the mean daily SO_2 maxima in Table 2. The maximum hourly SO_2 peaks in the northern part of the test region and at Svenvik sometimes exceeded $1000 \mu\text{g}/\text{m}^3$. On the basis of the mean annual SO_2 levels, $\mu\text{g}/\text{m}^3$, the test sites can be arranged in a series:

$S2 > S3 > \text{Viksofjell} > \text{Karpdalen} > \text{Svenvik} > S1 > \text{Noatun}$ 56.9 (43.1, 37.1, 21.3, 13.0, 9.9, 5.9)

Wind speed and direction were registered at Viksofjell and Svenvik during the entire test period. At Viksofjell wind directions 210° - 240° predominate and the speeds are greater than 6 m/s. There are virtually no calm

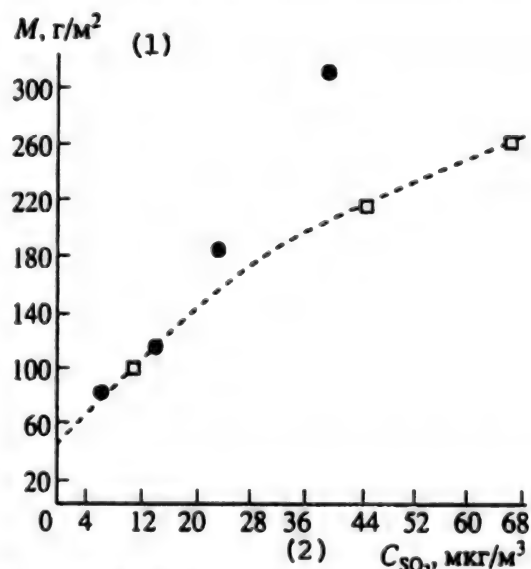


Fig. 7. Annual mass loss of carbon steel as function of mean annual sulfur dioxide concentration. Filled circles—sites in Norwegian territory; unfilled squares—sites in territory of Russian Federation.

Key: 1. M , g/m² 2. C_{SO_2} , $\mu\text{g}/\text{m}^3$

periods. At Svenvik the predominant directions are 180° - 240° . Directions 30° - 90° and 30° - 60° predominated only in June and July respectively. Directions 30° - 90° and 210° - 240° prevailed in May 1991. The wind speed at Svenvik did not exceed 4 m/s.

The described wind regime predetermined the highest SO_2 levels at sites S2, S3, Viksofjell and Karpdalen during the period from August 1990 through April 1991. In June and July 1990 and in May 1991 the mean monthly sulfur dioxide levels were low and fell in the ranges 8-11, 7-13, 11-13 and 5-8 $\mu\text{g}/\text{m}^3$ respectively.

The fallouts of chlorine and magnesium, $[(\text{m}^2 \text{ day})]$ increase in the series Svenvik \rightarrow Karpdalen \rightarrow Viksofjell (Table 3).

The quantity of precipitation falling at test sites during the investigated period was small (215.5-236.9 mm/g), but in most cases it had a pH level less than 5. The minimum pH (3.11) was registered at Svenvik in May 1991. The corrosivity of such acidic precipitation is unquestionable, but it is very difficult to represent it quantitatively in the form of a pH function due to the small differences in both the pH and in the quantity of precipitation falling at different test sites. The mean annual content of sulfates in the precipitation falling at Svenvik and Noatun was virtually identical (2.01 and 1.81 mg/liter respectively). At Karpdalen it was higher. Periodically in the precipitation there was a sharp increase in the chlorine concentration (especially at Karpdalen).

The Cl:Mg ratios in fallouts of aerosols, as well as the Cl:Na and Cl:Mg ratios in precipitation, in most cases corresponded to the ratios of these elements in sea water.

2. Corrosion data

Table 4 makes it possible to compare the losses of steel mass during three-month and yearlong tests and the sums of monthly losses during these same periods, as well as the annual losses of mass and the sums of losses during the four corresponding three-month exposures at sites in Norwegian territory [1, 7]. It can be seen that the

sum of the twelve one-month mass losses at all test sites exceeds the annual losses in continuous tests. The sum of mass losses during four three-month periods of this same year also exceeds them. However, the sum of the three one-month losses of steel mass ($M_1 + M_2 + M_3$) in more than 60 percent of the cases is lower than the mass losses in the case of a continuous three-month test (M_{1-3}). In most remaining cases (with average and small corrosion rates) they are approximately equal to one another.

A further analysis of Table 4 makes it possible to note: with a high corrosion rate (Viksofjell) in most cases the regularity $M_1 + M_2 + M_3 > M_{1-3}$ applies. In the case of small mass losses ($M_1 + M_2 + M_3$)/ M_{1-3} is usually far less than unity, and sometimes less than 0.5.

The results are consistent with the examined model. In three-month tests, taking in a considerable part of phase II, corrosion attains a maximum rate and the average mass loss is greater than the sum of the monthly losses. During the year corrosion products, having certain protective properties, are able to cover and screen the surface (phase III of curve 2, Fig. 2), and after passing through a maximum, the mean mass loss becomes less than the corresponding sum of the losses during one- or three-month tests integrally covering the same year.

Thus, the results indicate the existence of a threshold SO_2 level above which the air-oxide film on the steel surface is destroyed more rapidly and the corrosion rate increases sharply (Fig. 4). This is observed distinctly at sites with relatively low SO_2 concentrations.

Table 4. Comparison of synchronous corrosional losses of steel, g/m^2 : a—during one three-month (denominator) and three monthly exposures parallel to it (numerator); b—during yearlong (denominator) and 12 monthly (numerator) exposures; c—during yearlong (denominator) and 4 three-month (numerator) exposures

Period (month/year)	Viksofjell	Karpdalen	Svenvik	Kobbloss	Noatun
a					
10/88+11/88+12/88 / 10/88-12/88	163.0/134.7	57.3/51.0	17.0/13.0	13.3/12.3	13.3/12.7
1/89+2/89+3/89 / 1/89-3/89	150.3/156.0	61.3/77.7	27.0/28.0	18.3/18.3	23.7/19.7
4/89+5/89+6/89 / 4/89-6/89	132.7/122.3	75.3/73.3	61.7/58.0	59.3/50.3	39.3/29.7
7/89+8/89+9/89 / 7/89-9/89	202.7/153.7	75.0/82.1	55.0/65.0	41.0/53.0	15.9/38.0
10/89+11/89+12/89 / 10/89-12/89	139.2/130.7	60.8/72.8	17.4/29.3	6.8/17.3	9.3/19.7
1/90+2/90+3/90 / 1/90-3/90	88.7/116.1	45.7/69.1	18.8/40.5	18.6/30.9	16.0/25.9
4/90+5/90+6/90 / 4/90-6/90	92.1/108.1	34.1/56.7	13.2/31.3	16.8/38.3	11.8/22.6
6/90+7/90+8/90 / 6/90-8/90	122.0/108.0	57.7/66.0	27.1/40.0	34.4/44.0	27.4/37.0
9/90+10/90+11/90 / 9/90-11/90	152.0/143.0	83.0/21.0	36.4/42.0	33.6/36.0	30.5/32.0
12/90+1/91+2/91 / 12/90-2/91	112.0/98.0	55.6/46.0	23.7/19.0	21.0/16.0	30.6/21.0
3/91+4/91+5/91 / 3/91-5/91	84.0/97.0	43.9/54.0	21.5/39.0	14.4/31.0	10.6/20.0
b					
6/90+7/90+...+5/91 / 6/90-5/91	470.0/308.0	240.2/180.0	108.7/108.0	103.4/91.0	99.1/78.0
c					
6-8/90+...+3-5/91/6/90-5/91	446.0/308.0	187.0/180.0	140.0/108.0	127.0/91.0	110/78.0

Model curve 2 in Fig. 2 assumes a constant SO₂ level during the entire test period. In actuality, however, the SO₂ level may vary in a wide range. This is one of the reasons why the noted regularity is not observed in all cases.

According to Table 5 steel and zinc are most sensitive to air pollution by sulfur dioxide. In general the corrosion losses of materials correlate with the sulfur dioxide level if Viksofjell, where mass losses of steel, zinc, zinc plating and the "Alyutsink" plating were maximum, although the mean annual sulfur dioxide level (37.1 µg/m³) was not maximum, is excluded.

The annual losses of steel mass, depending on the mean annual sulfur dioxide level (Fig. 7) at five test sites are described well by a smooth curve. However, the sites corresponding to Karpdalen and Viksofjell fall above the curve, in contrast to the points S2 and S3 in Russian territory. This may be a result of a higher fallout of marine aerosols at these two Norwegian sites.

Table 6 gives the results of a linear regression analysis of the mass losses M of materials, g/m² as a function of the

mean SO₂ levels, µg/m³, for yearlong and some monthly test periods¹ using the equation

$$M = A_0 + A_1 C_{SO_2} \quad (1)$$

where A₀ and A₁ are constants.

The number of observations in Table 6 corresponds to the number of test sites. In all cases the correlation coefficient is quite high (only for June 1990 R = 0.083). Individual discrepancies between the loss of steel mass and the mean monthly SO₂ levels are observed at Kobbfoss and Svenvik in July 1990 and at site S1 in November 1990. In short-term tests in which the SO₂ level varies greatly the degree of correlation cannot but be reduced, in particular due to the asynchronous character of humidity and atmospheric pollution variations. For example, the mean monthly SO₂ concentrations at Svenvik and Viksofjell were 12 and 11 µg/m³ respectively; but the corrosion losses were 11 and 39 g/m² (since at Viksofjell high SO₂ levels were observed on the first days, whereas at Svenvik they were observed in the second half of the month).

Table 5. Corrosion losses, g/m² year) for yearlong exposure June 1990-May 1991

Material	Viksofjell	Karpdalen	Svenvik	Kobbfoss	Noatun	S1	S2	S3
Flat samples								
Steel	308	180	108	91	78	93	261	214
Zinc	24	12	9.6	8.6	5.4	6.4	19	15
Zinc plating	17	7.8	4.3	4.2	3.3	4.8	16	11
"Alyutsink" plating	10	5.3	2.4	1.8	1.5	2.8	9.6	6.9
Spiral samples								
Aluminum	1.8	0.5	0.4	0.2	0.1	0.2	2.6	1.2
Zinc plating	4.0	1.6	1.2	0.9	0.7	1.2	3.2	2.2
"Galfan" plating	-	1.0	0.6	0.5	0.4	0.9	2.8	1.9

Table 6. Constants A_1 , A_2 and correlation coefficient R of regression equation (1) for monthly and yearlong atmospheric exposure at all test sites

Material	Period (month/year)	Number of observations	A_1	A_2	R
Flat samples					
Steel	7/90	6*	-36.690	7.310	0.964
Steel	8/90	8	1.403	1.282	0.975
Steel	9/90	8	3.485	1.283	0.921
Steel	10/90	6**	7.553	0.973	0.968
Steel	5/91	4	-5.555	2.510	0.914
Steel	6/90-5/91	6**	68.197	3.496	0.968
Zinc	6/90-5/91	6**	5.061	0.247	0.972
Galvanized steel	6/90-5/91	6**	1.985	0.235	0.987
Steel with "Alyutink" plating	6/90-5/91	6**	1.034	0.149	0.978
Spiral samples					
Aluminum	6/90-5/91	6**	-0.277	0.044	0.958
Galvanized steel	6/90-5/91	6**	0.610	0.043	0.981
Steel with "Galfan" plating	6/90-5/91	6**	0.175	0.044	0.980

*Without allowance for Svenvik and Kobbfoss

**Without allowance for Viksofjell and Kobbfoss

For predictive estimates it is necessary to have an atmospheric corrosion model taking into account both sulfur dioxide and moistening time. Its variants were examined on the basis of monthly tests in August and September 1990 and for the total period:

$$M = A_1 + A_2 C_{SO_2} + A_3 \tau, \quad (2)$$

$$M = (A_1 + A_2 C_{SO_2}) \tau, \quad (3)$$

$$M = [A_1 + A_2 (C_{SO_2})^{A_1}] \tau^{A_4}, \quad (4)$$

where τ is moistening time, in hours; A_1 - A_4 are constants.

According to a regression analysis (Table 7), the high correlation coefficient for both August and September 1990 corresponded to equation (2). However, the negative constant on τ (A_3) does not agree with the physico-chemical regularities of atmospheric corrosion. Equation (3) seems to be more applicable. In the case of use of equation (4) the A_3 and A_4 coefficients do not differ greatly from unity.

Table 7. Constants A_1 - A_4 of equations (2)-(4) during periods 8/90, 9/90 and 8/90+9/90 (R^2 —square of correlation coefficient, N —number of equation)

Period (month/year)	N	A_1	A_2	A_3	A_4	R^2
8/90	2	42.084	1.194	-0.110	-	0.984
8/90	3	0.00540	0.00352	-	-	0.855
9/90	2	-52.272	1.128	0.160	-	0.919
9/90	3	0.00627	0.00354	-	-	0.935
9/90	4	0.0000386	0.0009357	0.922	1.279	0.947
8/90+9/90	2	-9.833	1.280	0.034	-	0.897
8/90+9/90	3	0.00571	0.00354	-	-	0.899

Table 8. Constants A_1 - A_3 of equation (5) in calculation of moistening time from temperature thresholds: $T > -2, -4$ and -6°C during periods 8/90-11/90 and 2/91-4/91 (R^2 —square of correlation coefficient)

Temperature, $^\circ\text{C}$	A_1	A_2	A_3	R^2
> -2.0	-0.261	0.00878	0.0001	0.786
> -4.0	-0.156	0.00767	0.000035	0.963
> -6.0	-0.0728	0.00566	0.00001	0.810

Table 9. Corrosive moistening time τ ($R_h > 80$ percent and $T > -4^\circ\text{C}$), mean SO_2 level, mass losses M and mean rate V of steel corrosion at Noatun, site S1, Svenvik and Kobbfoss during different periods during time of yearlong tests

Time period (month/year)	hours	Noatun			S1			Svenvik			Kobbfoss		
		SO_2 , $\mu\text{g}/\text{m}^3$	M , g/m^2	V , $\text{g}/(\text{m}^2 \text{ hour})$	SO_2 , $\mu\text{g}/\text{m}^3$	M , g/m^2	V , $\text{g}/(\text{m}^2 \text{ hour})$	SO_2 , $\mu\text{g}/\text{m}^3$	M , g/m^2	V , $\text{g}/(\text{m}^2 \text{ hour})$	SO_2 , $\mu\text{g}/\text{m}^3$	M , g/m^2	V , $\text{g}/(\text{m}^2 \text{ hour})$
6/90	268	7.0	7.2	0.027	13.0	4.8	0.018	12.0	5.1	0.019	14.0	6.7	0.025
7/90-8/90	783	5.0	29.8	0.038	6.5	24.2	0.031	11.5	34.9	0.045	37.3	0.048	
9/90-5/91	1366	6.0	41.0	0.030	10.3	64.0	0.047	13.4	68.0	0.050	-	-	-

$M(7-8/90) = M(6-8/90) - M(6/90)$; $M(9/90-5/91) = M(6/90-5/91) - M(6-8/90)$.

The results of the monthly tests during the course of the year cannot be evaluated without precise allowance for moistening time. It is usually assumed that $T > 0^\circ\text{C}$ is the necessary temperature condition for corrosion-dangerous (that is, "corrosive") surface moistening (and this also means inclusion of the corresponding time segment in τ). However, this contradicts the results: the corrosion losses of mass were observed during periods when even the maximum temperature levels were negative and the traditionally computed moistening time must be equal to zero. In order to find the actual temperature limit of corrosive moistening the monthly steel losses at Viksofjell were investigated as a function of the SO_2 level, the rate of fallout of chlorides and the moistening time (determined for $T > -2, -4$ and -6°C) using the equation

$$M = (A_1 + A_2 C_{\text{SO}_2} + A_3 C_{\text{Cl}}) \tau. \quad (5)$$

It can be seen from Table 8 that a maximum correlation is observed when a value $T = -4^\circ\text{C}$ is adopted as the lower temperature limit for reading τ . A negative constant term A_1 in the equation also indicates that this equation is applicable in the SO_2 region above the threshold. It is evident that this conclusion also must apply to the derived equations (3) and (4).

Earlier corrosion research in the copper-producing industry city of Sulitjelma, Norway, indicated that the temperature limit in reckoning the moistening time of steel falls between -2 and -4°C , and is even lower for zinc [8]. A similar effect also was observed earlier in research

in the former USSR. Accordingly, State Standard 9.039-74 [9], prepared by the Physical Chemistry Institute, Russian Academy of Sciences, took into account the possibility of development of atmospheric corrosion at a temperature above -1°C .

The new experimental results make it necessary to assume that the corrosive films of the electrolyte in a moist atmosphere exist even at a lower temperature. In a subarctic climate with a very short summer and a temperature below zero, observed during 9-10 months of the year, a correct determination of the temperature threshold of corrosive moistening is especially important (although in a tropical and subtropical climate such a problem is simply absent and in a temperate climate its value is low).

In refining the temperature limit of reckoning τ (-4°C) it is possible to estimate the rate of steel corrosion (per hour of moistening) in the course of a yearlong exposure for the first, second- third and fourth-twelfth months of the tests at sites with a low SO_2 level, Table 9. It can be seen that the minimum corrosion rate is observed in the first month of the tests. During the next two exposure periods the corrosion rate increases, sometimes even with some decrease in the mean SO_2 level, which is consistent with the existence of a concentration threshold above which the corrosion rate increases. The results of monthly July tests in 1990, for which the term A_1 in equation (1) is negative (Table 6), make it possible to assume that for steel the SO_2 interval $5-10 \mu\text{g}/\text{m}^3$ is the threshold level.

In general, the correlation of the SO_2 level and the loss of mass of metals during different time periods was good,

which makes it possible to regard atmospheric corrosion tests to be one of the tools for long-term pollution monitoring.

Summary

The results of corrosion tests show that anthropogenic atmospheric pollutants determine atmospheric corrosivity even in a subarctic climate. Physicochemical models describing corrosion in other climatic regions are applicable to it, but taking into account that the real temperature threshold of surface corrosive moistening lies below 0°C.

An analysis of the results led to the following conclusions:

1. The temperature-humidity characteristics of the test sites and the quantity of precipitation at them differ insignificantly.
2. The predominant wind directions (210°-240° at Viksofjell and 180°-240° at Svenvik) result in the transport of sulfur impurities from Nikel and Zapol'yarnyy and increase corrosion at sites S2, S3, Viksofjell and Karpdalen.
3. Dry fallout of chlorides increase in the series Svenvik → Karpdalen → Viksofjell. The Cl/Mg ratio shows that the principal Cl source is marine aerosols which during the period from November 1990 through March 1991 made their contribution to atmospheric corrosion at Viksofjell and in part at Karpdalen.
4. Precipitation has an increased acidity and an increased concentration of sulfates. The Cl, Na and Mg in precipitation correspond to the ratios of these elements in sea water.
5. The noncorrespondence between corrosional losses and the traditionally determined moistening time during the period from October 1990 through May 1991 indicates an active transpiring of corrosion, that is, the existence on the metal of a corrosive electrolyte even at a negative air temperature.
6. Synchronous corrosional losses at different test sites are dependent primarily on the mean concentration of SO₂ at them during the exposure period. The corrosion rate at Viksofjell was greater than expected in comparison with the remaining sites, but is natural if allowance is made for the influence of chlorides and corrosion at a negative temperature.
7. The high sensitivity of metal corrosion to the air pollution level can be used for ecologic monitoring.

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Bibliography

1. Henriksen, J. F., Mikhailov, A. A. and Mikhailovskiy, Y. N., Atmospheric Corrosion Tests Along the Norwegian-Russian Border, Lillestrom, Norwegian Institute for Air Research, 1992 (NILU OR 54/92).
2. ISO 9226:1992(E). Corrosion of Metals and Alloys—Corrosivity of Atmospheres—Determination of Corrosion Rate of Standard Specimens for the Evaluation of Corrosivity.
3. Standardiseringskommissionen i Sverige: SIS 141316. Cold Rolled Thin Steel Sheets for Construction Purposes (in Swedish), Stockholm, 1977.
4. Anda, O. and Haagenrud, S. E., Sea-Salt Deposition Measured With NILU'S Precipitation Collectors and Aerosol Traps (in Norwegian), Lillestrom, Norwegian Institute for Air Research, 1984 (NILU TR 8/84).
5. ISO 9223:1992(E). Corrosion of Metals and Alloys. Corrosivity of Atmospheres—Classification.
6. Hellevik, O. and Sivertsen, B. Air Quality in the Border Areas Between Norway and USSR. Model Description and Preliminary Modelling Results, Lillestrom, Norwegian Institute for Air Research, 1991 (NILU OR 23/91).
7. Hagen, L. O., Henriksen, J. F., Johnsrud, M. and Sivertsen, B., Basisundersøkelse av luftforurensninger i Sor-Voranger 1988-1990. Framdriftsrapport nr 2 pr 1.3.1990, Lillestrom, Norwegian Institute for Air Research, 1990 (NILU OR 17/90).
8. Henriksen, J. F. Corrosion by SO₂ in Sulitjelma, a copper mining town in Norway, in: 11th Scandinavian Corrosion Congress, Stavanger, 1989. Proceeding. Stavanger, Hogskolesenteret i Rogaland, P F48, 1989.
9. GOST 9.039-74. Yedinaya sistema zashchity ot korrozii i stareniya. Korroziionnaya agressivnost atmosfery (State Standard 9.039-74. Unified System for Protection Against Corrosion and Ageing. Atmospheric Corrosional Aggressiveness).

Footnote

1. Monthly tests were not made at sites S1-S3 during the period from November through April and therefore a regression analysis was not used for evaluating the results during this period.

Ground Water Pollution by Hydrocarbons

957A0371A Moscow GEOEKOLOGIYA in Russian
No 1, Jan-Feb 95 (manuscript received 27 Dec 93)
pp 3-27

[Article by V. A. Mironenko and N. S. Petrov, St. Petersburg Mining Institute; UDC 624.131]

[FBIS Abstract] The results of research in Russia and abroad in the field of study of contamination of ground water by hydrocarbons are generalized. For example, information is given on the characteristics of migration of hydrocarbons, with tables and diagrams giving the results of experiments on the wetting angle of heavy hydrocarbons immiscible with water and data on residual saturation. Such subjects as the dependence of capillary pressure on surface tension and wetting angle also are discussed. Dissolution and evaporation processes are examined in detail. Particular attention is devoted to an analysis of the influence exerted on the propagation and transformation of hydrocarbons by heterogeneity and nonuniformity of rocks, physicochemical processes (sorption and biodegradation of hydrocarbons, with biodegradation usually being far more intensive than nonbiological degradation), variations of groundwater levels and other governing factors. Experimental data are given on solubility, specific density, viscosity, surface tension and residual saturation and sorption parameters of individual organic compounds (pertinent data are given in a series of tables). The possibilities of field methods for the detection and cleanup of hydrocarbons are analyzed after a discussion of observation and sampling procedures. These cleanup methods include pumping out of contaminants, removal of residual hydrocarbons by methods similar to those employed in stimulating oil yields and extraction by aeration and biological methods, each of which are discussed in detail with an evaluation of their strong and weak points. Figures 2; tables 5; references 43: 2 Russian, 41 Western.

Causes and Trends of Change in Groundwater Quality

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No 1, Jan-Feb 95 (manuscript received 28 Jun 93)
pp 36-49

[Article by S. R. Kraynov and V. P. Zakutin, All-Union Scientific Research Institute for Hydrology and Engineering Geology; UDC 624.131]

[FBIS Abstract] This review summarizes the natural geochemical processes responsible for high concentrations of chemical elements in groundwater. The formation of groundwater with an increased content of recognized toxic components is the result of natural and technogenic geochemical processes. Among the natural processes the most important are: increase in the mineralization of groundwater as a result of its evaporative

concentration and desalinization of halogenic formations, change in the ratios between sodium and calcium, change in the redox potential of waters and an increase in the concentrations of components which are complex formation ligands. Together with technogenic processes (entry into aquifers of industrial, agricultural, communal-household sewage, irrational exploitation of groundwater deposits), natural processes result in the following phenomena: formation of regional hydrogeochemical provinces of polluted waters, increase in ecologic significance of individual groups of organic substances and formation of new easily migrating toxic forms of chemical elements and compounds. A table lists the concentrations of 24 of the most important organic substances (in actuality, there are at least 100 and possibly many more) found in groundwater and particular attention is given to those which are becoming more common. Several maps show the groundwater hydrochemical provinces in the former USSR with high levels of contamination by a whole series of elements and compounds. Figures 7; table 1; references 20: 13 Russian, 7 Western.

Problem of 'Self-Burial' of Radioactive Wastes

957A0371C Moscow GEOEKOLOGIYA in Russian
No 1, Jan-Feb 95 (manuscript received 2 Nov 93)
pp 96-102

[Article by L. Ya. Kosachevskiy and L. S. Syui, Moscow State University of Environmental Management; UDC 532.5.01.536.24]

[FBIS Abstract] Since the practice of burial of radioactive wastes in geologic formations is both costly and of unknown reliability, a less costly and more reliable alternative must be sought. "Self-burial," economically and ecologically attractive, is being given increasing attention. Accordingly, the problem of movement of a spherical capsule with radioactive wastes in molten rock (the melting occurs due to the heat released by wastes during radioactive decay) under the influence of its own weight was solved after a thorough theoretical examination. It is noted that although a similar problem was recently examined by Emerman, et al., and Moallemi, et al., the source considered was in the form of a uniform sphere and cylinder and its surface temperature also was assumed to be uniform, simplifying mathematical solution of the problem but not corresponding to reality. At the lower critical point of a spherical source the temperature extremely insignificantly exceeds the temperature of medium melting, whereas at the upper critical point it may be several times greater and increases with an increase in radius. There is therefore a maximum admissible radius at which this temperature attains the melting point of the spherical capsule. The rate of sinking and the temperature field were determined. An expression was derived for the maximum admissible radius with which the container remains in a solid state. A study was made of the dependence of this radius and the corresponding

rate of sinking on the thermal conductivity of the capsule. The results are illustrated by numerical examples for cases of sinking in molten basalt, granite and quartz. Figures 3; table 1; references 6: 3 Russian, 3 Western.

Extent of Near Zone for Flat Coaxial Ultrasound Transducers

957A0372A Moscow *AKUSTICHESKIY ZHURNAL* in Russian Vol 41 No 1, Jan- Feb 95 (manuscript received 18 Nov 93) pp 101-105

[Article by I. I. Kryukov, St. Petersburg Technological Institute; UDC 534.26:534.61]

[FBIS Abstract] The formulas derived by different authors for the mean pressure on a flat disklike transducer situated on the same axis with a disklike emitter are analyzed on the assumption that the emitter in the form of a circular disk with a given area is a unidirectional rigid piston in a plane infinite screen. Absorption of ultrasound in the medium is not taken into account. The distribution of amplitudes of oscillatory velocity at the transducer surface is assumed to be uniform. With these simplifying assumptions taken into account, computations of the near zone (and accordingly, choice of the frequency range) when performing ultrasound monitoring of objects of finite dimensions are made with allowance solely for sound source dimensions. The near field concept can be introduced on the basis of an analysis of data published by various authors by analogy with the near zone of the acoustic field of an individual transducer. By the term "near field" is meant the distance between the emitter and receiver along the axis corresponding to the last acoustic pressure diffraction maximum, after which the acoustic field changes smoothly. The extent of the near zone of the emitter-receiver system is determined by their wave dimensions and is close to (somewhat exceeds) the sum of the extents of the near zones of the emitter and receiver individually. Therefore, in ultrasound monitoring for a more precise determination of the position of the boundary between the near and distant zones it is necessary to take into account the wave dimensions of both the emitter and receiver. The findings are correct for transducers of any size. Figures 2; references 12: 10 Russian, 2 Western.

Determining Frequency-Angle Dependence of Bottom Sound Reflection Coefficient in Shallow Sea

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[Article by V. M. Kurtepov, Oceanology Institute imeni P. P. Shirshov, Russian Academy of Sciences; UDC 534.2]

[FBIS Abstract] Predictions of low-frequency sound fields in shallow seas where there are multiple reflections from the bottom are based on a knowledge of the coefficient of reflection of sound waves from the bottom,

but classical methods for its determination using ordinary emitting and receiving systems are impracticable in the low-frequency range due to difficulties in identifying arriving signals with the corresponding rays. Accordingly, an alternative interference approach is proposed for determining the frequency-angle dependence of the amplitude and phase of the sound reflection coefficient by using several vertical sound intensity sections at different distances from the sound source. After derivation of the pertinent formulas for the procedures involved, the accuracy of the method is evaluated on the basis of the results of a numerical experiment involving examination of a specific flat uniform waveguide with a constant speed of sound in water lying on an arbitrary layered-inhomogeneous half-space. Such a model corresponds to a shallow sea with negligible sound refraction in the waveguide. It is shown that use of a multifrequency sound source (operating, for example, at 200 and 300 Hz) makes it possible to obtain the dependence of the reflection coefficient on both angle and frequency. The advantages and limitations of the method are discussed. A comparison of the precise and mean energy reflection coefficients in a wide range of angles and frequencies made it possible to recommend the mean energy coefficient of sound reflection for estimating propagation conditions in a shallow sea. Figures 3; references 5: 4 Russian, 1 Western.

Acoustic Tomography of Internal Waves in Ocean

957A0372C Moscow *AKUSTICHESKIY ZHURNAL* in Russian Vol 41 No 1, Jan- Feb 95 (manuscript received 18 Mar 94) pp 112-116

[Article by B. F. Kuryanov, A. K. Morozov and G. K. Timashkevich, Oceanology Institute imeni P. P. Shirshov, Russian Academy of Sciences; UDC 551.596]

[FBIS Abstract] The results of an experiment for observing internal waves of tidal origin carried out on the second cruise of the Akademik Sergey Vavilov are presented. There is only a limited amount of experimental data on internal waves of tidal origin and therefore each such observation is of interest. Internal waves of tidal origin were studied by the acoustic tomography method based on retrieval of the dependence of the speed of sound on depth and time $C(z,t)$ from variations of the time of propagation of acoustic signals along different paths between self-contained bottom stations. The experiment was carried out in the Atlantic on the slope of Cruiser Tablemount on 15-16 October 1988 using two self-contained bottom stations spaced at a distance 23.5 km apart in a direction perpendicular to the postulated direction of internal wave propagation. These stations were outfitted with receiving-transmitting instruments emitting complex acoustic signals. Signals were propagated along five rays. In solving the inverse problem use was made of a model of internal wave oscillations constructed on the basis of stochastic differential equations and optimum methods for nonlinear filtering of Markov processes. Since this experiment was

one of the few based on the tomography of internal waves and the only one carried out in Russia it was not without shortcomings. The relatively small number of rays used in retrieving the $C(z,t)$ dependence makes it impossible to guarantee a good accuracy in estimating the dependence of speed of sound on depth and time, but an approximate estimate can be made of individual internal wave parameters and the qualitative pattern of the observed hydrodynamic processes. In the upper part

of the ocean it was easy to trace speed of sound variations with a 12-hour period. The amplitude of these variations increased with depth and at a depth of 800 m attained a maximum of 50 m. At greater depths the pattern changed qualitatively. The nature of speed of sound change with time is attributable to interaction between tidal currents along the tablemount slope and an internal wave of tidal origin propagating in the upper part of the ocean. Figures 4; references: 4 Western.

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